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BOMBAY. Govt. Plague Commissioner

REPORT

ON THE

EPIDEMIC OF PLAGUE

FROM

22nd February to 16th July 1897,

BY

JAMES A. LOWSON, M.B. (Hong Kong Civil Service),
Plague Commissioner, Bombay.



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R E P O R T

To the Secretary to the Government of Bombay.

HIGHER ADMINISTRATION AND DUTIES.

London,
31st October 1897.

Sir,

I have the honour to report that Surgeon-Major W. L. Reade and I were deputed to Bombay to advise and assist the Bombay Government authorities in devising and carrying out measures necessary to suppress the epidemic of plague which broke out in that city in August 1896.

2. We arrived in Bombay on the 22nd February 1897, took up duties forthwith, and did not leave India until 16th July 1897, when the plague epidemic had been reduced to very small dimensions.

3. Our first recommendation made after arrival in Bombay was that a Plague Committee should be formed in Bombay to carry out, independently, the measures which were, in our opinion, necessary to combat the epidemic.

4. On the 5th March 1897 the Government of Bombay formally appointed a Plague Committee as follows :—

1. Brigadier-General Gatacre, C.B., D.S.O., Chairman.
2. P. C. H. Snow, Esq., Municipal Commissioner.
3. Surgeon-Major Dimmock, I.M.S.
4. C. C. James, Esq., Municipal Engineer.

The powers granted for the suppression of plague, which had hitherto been vested in the municipality, were by order of the Government henceforth placed exclusively in the hands of this Committee.

5. Plague Committees were appointed, and powers granted, for Poona on 9th March, consisting of—

- W. C. Rand, Esq., I.C.S., Chairman.
- Lieutenant-Colonel C. R. Phillipps.
- Surgeon-Captain Beveridge, A.M.S.

For Karachi on 24th March :—

- Brigadier-General T. A. Cooke, Chairman.
- R. Giles, Esq., Collector of Karachi.
- Surgeon-Captain Arnim, I.M.S.
- J. Strachan, Esq., Municipal Engineer.

For Sukkur on 30th March :—

- Lieutenant-Colonel Mayhew, Chairman.
- W. H. Lucas, Esq., I.C.S.
- Surgeon-Major Corkery, I.M.S.
- W. A. Myles, Esq., Secretary to Municipality.

A Committee was also formed for work in Hyderabad (Sinde), the latter three acting under Mr. Wingate, the Commissioner for Sind.

6. In other parts of the Presidency where plague was present, the powers granted by the Epidemic Diseases Act were carried out by the Local Government authorities, who consulted us on measures and details of organisation, &c., as occasion demanded.

In two native states, Cutch and Palanpur, measures were carried out by the Bombay Committee and Surgeon-Captain Cleveland, I.M.S., respectively, under the political agents at Bhuj and Palanpur.

Our general duties were embodied in Government Resolution No. 1109/596 P., of 2nd March 1897.

"Dr. Lowson and Surgeon-Major Reade are to be addressed as Joint Plague Commissioners. They are attached to the General Department of the Secretariat, will correspond direct with that Department, and receive orders therefrom. Secretariat papers sent to the Joint Plague Commissioners for opinion should go to them by unofficial reference.

"The Joint Plague Commissioners are directed to keep themselves informed of the existence and extent of the plague both in the city of Bombay and elsewhere, and of the operations against it. They should advise and help the officers and committees engaged in operations against the plague, and inspect such operations as far as they are able. They should jointly or singly, as far as they are able to do so, visit the various places where plague operations are in progress.

"All officers of Government, all Departments, all municipalities, local boards, and officers thereof, should give the Joint Plague Commissioners all the information and assistance they may require."

Instructions were given that the present report should be prepared by Surgeon-Major Reade and myself; but the former has again been sent to India on plague duty before the present report could be completed. I have therefore been obliged to draw it up alone. Hereafter Surgeon-Major Reade will doubtless be able to submit a further report after his wider experience of plague and plague administration.

INFECTION.

Short description of Plague.—For the purpose of this Report a very short description of plague is necessary. Bubonic plague belongs to the group of diseases known as contagious and infectious septicæmias. It has an incubation period of from two to six days, usually three or four, but this period may extend to nine days, whilst one authenticated case in Hong Kong is recorded in which it was fifteen. The possibility of the occurrence of a febrile attack indicating the presence of the disease, but being overlooked because of the absence of pathognomonic signs, must in this case however be carefully borne in mind. In man plague is usually ushered in with fever and severe headache, sometimes vomiting, accompanied or followed in the majority of cases by the well-known glandular swelling in one or more regions of the body. The fever persists, delirium sets in, and in from two to six days the patient is overcome by the power of the poison and dies, the effect of the virus on the heart usually being the immediate cause of death. The mortality amongst Asiatic races is usually from 90 to 100 per cent. outside hospital, whilst careful treatment in hospital often brings the death-rate down by 20 per cent. or even more. The disease may assume one of several types. In many cases the lungs are early affected, usually about the second day, and infarcts formed and inflammation set up, with copious expectoration in cases where death does not occur until after the third day. In these cases small infarcts and patches of inflammation are usually found after death throughout the lung, whilst, in addition, the posterior parts of the lung are always œdematous and congested. In other cases dysenteric symptoms may predominate, a foul-smelling diarrhœa being accompanied by straining and passage of blood and mucus. In these cases the bowel is frequently inflamed and small hæmorrhages are generally met with in the mucous membrane throughout the whole intestinal canal. The hæmorrhagic patches frequently become eroded and sometimes profuse hæmorrhage may occur. In a third group of cases there is congestion or inflammation of the kidney, which is well marked on post-mortem examination. In such cases albumen is usually found in the urine; casts are also frequently found. Ecchymoses or hæmorrhages, large or small, in most of the serous and mucous membranes of the body may be found on post-mortem examination. Large hæmorrhages, however, are comparatively rare. The escaped blood, when in the lung, bowel, or kidney, may be passed out of the body by the usual channels. In another distinct group of cases the lungs are especially affected, and there may be no signs of any primary glandular swelling (although here the bronchial and mesenteric glands are frequently congested or inflamed). In these cases the patient may die without any prominent symptoms other than fever and delirium. In

some cases again the poison appears to be more distinctly localised in the glands in contradistinction to those cases in which there is the septicæmic condition, in which the poison rapidly invades the whole body.

The bacillus.—Plague is caused by a specific organism, the plague bacillus, first discovered by Kitasato in 1894 in Hong Kong. It is a short thick bacillus about 1·2 m.m. long and ·6 m.m. broad, which stains easily with aniline dyes, the two ends taking the stain more deeply than the middle part.

Mode of exit from body of man.—The plague bacillus is found in large numbers in the primary buboes and in all the internal organs of the body in septicæmic cases. It is also found in considerable numbers in the hæmorrhages which are frequently met with in the mucous membrane of the walls of the intestinal canal and urinary tract. It is similarly very frequently met with in the excretions from affected lungs. Any or all of the excretions may contain the typical bacilli. From the sputum of advanced cases a cultivation of plague bacilli which kills animals susceptible to plague can generally be procured; from the animals so affected, the plague bacillus can again be procured in pure culture. Cultivations from fæces in cases which show marked hæmorrhagic condition of the bowel yield plague bacilli which also kill ordinary susceptible animals. Some observers have denied the infecting power of the fæces, or at least have not mentioned it as a factor in the spread of the disease. In Hong Kong many severe cases of dysenteric-like diarrhœa occurred in the hospitals, where abdominal tenderness was present along with great colic. At the autopsy the inflammation of the gut was extreme, with numerous small erosions of the hæmorrhagic patches. These hæmorrhages in the mucous membrane are from the size of a pin head up to a pea or even larger. In these the bacilli are found in considerable numbers. Such hæmorrhages very frequently give way to small erosions, more especially in the lower part of the lesser bowel. As a rule no distinct sloughs can be found preceding these erosions, especially in this position. Many rabbits were inoculated with fæces, and a considerable number of them died from plague. Fæces from virulent cases were also spread in cages in which mice were afterwards kept. Some of these mice died from plague but others remained unaffected. There is evidence from the Hong Kong epidemic in 1894 that accumulations of fæcal matter may give rise to infection in surrounding houses, as it was notorious that in a badly infected area, which was not evacuated by the population, the infected houses were grouped around the latrines which had been kept in a very insanitary condition owing to the great scarcity of labourers. Certain observations made in Hong Kong afford further evidence of this mode of infection. Several healthy monkeys occupying a cage below one containing plague-infected rabbits contracted the disease, apparently from the droppings from the infected rabbits above. The bacillus has been isolated from the bile of a dead plague patient, another source for infection of fæces.* Bacteriological experiments carried out by Wilm† in Hong Kong over a long period proved that in a large number of cases the fæces contained the bacilli; as I saw these experiments and in the further light of the above observations, I am compelled to the conclusion that the fæces are infective, and that, moreover, in some of the severe cases accompanied by dysenteric symptoms, clothes may become infected by this excretion, the soiled clothing remaining a source of danger until it is destroyed or disinfected.

From the urine, more especially where there is a large quantity of albumen present, cultivations of plague bacilli may often be obtained. The bacilli in such cases are often associated with hæmorrhages into the pelvis of the kidney or into the mucous membrane of the lower part of the urinary tract. The plague bacilli have not been found so far in the milk of the human body.

Conveyance by rats, insects, and vermin.—The excretions of rats are probably infective in the same way, but as yet I have no experimental data on this point; but it is known that the disease affects rats in an epidemic fashion

* Ogata, "British Medical Journal," 9th October 1897.

† Wilm, "Report on Plague in 1896 to Government of Hong Kong," Novonha & Co., Hong Kong.

much as it affects man, and that in their organs and blood plague bacilli can be easily demonstrated.

Yersin* states that he has found the plague bacillus in flies, but the probability of the disease being propagated to any serious extent by flies is extremely small, as flies are present in very large numbers in most plague hospitals, and, notwithstanding the swarms of them which must be continually carrying about bacilli on their wings even in very insanitary plague hospitals, very few cases of infection have occurred. From a practical point of view, this method of infection cannot be seriously treated. It is stated by Jablonowski that flies played an important part in the epidemic in Mesopotamia in 1884, their appearance and disappearance coinciding with that of the epidemic. It should be observed, however, that in the many plague hospitals I have seen, where flies and mosquitoes have simply covered the patients, in the interval feeding on infected sputum, &c., infection of healthy persons by them has been extremely rare. It must not be ignored, however, that flies may carry infective particles, though contamination by this means, and in dirty infected houses flies and other vermin, lice, &c., have frequent opportunities of carrying the fomites of the disease. In any case, if this method of infection should occur at all frequently, it is only another reason for the most rigid isolation in a hospital away from human habitation, where flies and other insects may be lured to their destruction by various fly poisons, &c. In a plague hospital flies do not usually die in numbers unless poisoned by attendants; plague is probably not the cause of their death.

Infection of animals.—The smaller and domestic animals which are most susceptible to plague are mice, rabbits, guinea-pigs, rats, and monkeys. Guinea-pigs and rabbits of course, from their habits and surroundings, do not usually transmit the disease and certainly can seldom have much to do with the outbreak or spread of an epidemic. Wilm,† experimenting on animals in Hong Kong in 1896, reports that a pig which had eaten plague spleens died twenty-two days after last partaking of that food. This experiment giving positive evidence of infection, if it can be corroborated by any future evidence, will be important. I have made many attempts to bring about infection of pigs by inoculation and feeding, but these all failed, as no trace of the disease could be found in any of the animals experimented upon. From these and other experiments made on pigs and cattle, however, it can be said they certainly do not suffer from the disease in an acute form. If, however, a chronic or sub-acute form of plague can thus occur, it might go a long way towards solving the difficulty of the propagation of plague from time to time. The propagation of the disease in a subacute or chronic form will certainly have to be studied in the near future, although its application to India will have little or no importance in connection with plague as an epidemic disease. In China, however, where pigs infest every town and village, the question of propagation of a chronic plague might prove to be one of very great importance. Infection of sheep, oxen, swine, dogs, cats, and deer is frequently spoken of, but, as a rule, the animals above named are very insusceptible to inoculation with the disease. and a very large and intimate street experience of plague compels me to the conclusion that swine, dogs, and cats play a very unimportant, if any, part in the transmission of plague, unless they carry the infection on their coats or fur. In India I came across an epizootic amongst cats in a plague village, but the cause of death was probably starvation, as no plague bacilli could be discovered in any of them. Some observers claim that the cat is susceptible to plague, but it must be looked upon as an animal to and through which it is difficult to transmit the disease. Plague certainly does not occur in an epizootic form amongst cats.

Mode of infection of man.—On the method of infection it may be desirable to say a few words. The commonest mode must be by inoculation, as external primary buboes are present in from 60–90 per cent. of all cases. Physiology and anatomy teach us that the irritating cause of these primary swellings must be introduced in the region which is drained by these lymphatic channels. The difficulty that certain observers have had in accepting this mode of infection has been due to the fact that, in experimenting on animals,

* Annales d'Institute Pasteur.

† Wilm., *loc. cit.*

œdema and surrounding inflammation have always been such marked features that the same features have been expected to follow primary inoculations in the human subject. It must be remembered, however, that even experimental inoculation of animals is not always followed by œdematous inflammation. When rabbits are inoculated through a large superficial incision and a large loopful of virulent culture is applied, a considerable amount of inflammation undoubtedly occurs; but when they are merely punctured on one of the hind legs with the point of a knife which has just been "touched" on culture, many cases are seen in which no inflammation occurs round the inoculation point although the animal dies. I made experiments on this subject in 1895, and similar experiments have been carried out in Bombay by the Russian Commission, who experimented on monkeys with much the same results. With them it was found that large doses of the virus introduced through large wounds caused inflammation and surrounding œdema, but "puncture on the palm of the hand or finger by a needle soiled by a culture" also caused death, but with no other local symptoms than enlarged gland or glands in the axilla. The external mucous membranes of the body come into the same category. Those of the male and female genital organs, mouth, nose, and eyes may all allow entrance, especially the first named, which I have frequently seen. One well marked case of a mixed infection of plague and syphilis came under my observation. Many cases of mixed plague and streptococcus infection have also been observed and recorded, whilst the Russian Commission to Bombay in 1897 have found that in pneumonic cases of plague the pneumococcus is frequently associated with the plague bacillus. Mixed infection with typhoid bacilli is almost undoubted. This association, however, is more peculiar than the previous mixed infections, as though inoculable diseases are naturally from their mode of transmission associated with plague typhoid is alimentary in origin, and, as will be seen later, it is doubtful if plague infection is ever induced through the intestine. With regard to the Indian epidemic, many of the filthy habits of the country predispose to the rapid spread of infection by inoculation: *e.g.*, expectoration on floors and walls, an ineradicable Oriental habit. In the case where the sputum is especially infective it will be readily seen that the room may become saturated with the poison, from which further infection by inoculation of members of the household may take place. The usual cycle of events is for man to bring in the poison; his lungs become affected in a large number of cases, and he expectorates the poison on to the clothes and floor and other contents of the house, which in turn infect others. In cases in which the infective agent is introduced by a wound, the order in which various parts and systems are invaded is now fairly well defined. From the wound the virus makes its way to the neighbouring proximal glands, where, as a result of the irritation set up, buboes or bubonic swellings are formed. Thence the bacilli may in time, in severe cases, make their way into the efferent veins and so to the right heart, the lungs and the left heart, from which they find their way into the arterial system and finally into the terminal arteries. Here, as in the terminal veins of the lung, they may give rise to small embolic or thrombotic infarctions, which, as we have seen, may be followed by ulceration when the terminal vessels are near a free mucous surface.

The house infection above-mentioned has always been marked in plague, and in working in a plague-infected locality one is immediately struck by the fact that a considerable number of cases occur in one house, whilst the surrounding houses are practically free. In an epidemic where removal to hospital is not carried out with the first case or cases, this almost always occurs. Infection by respiration also takes place, but is comparatively infrequent. It is generally due to inhalation of plague-infected dust, which is inhaled and lodges in abrasions of the mouth or crypts of the tonsils. It is doubtful if true lung infection takes place in these cases. The bacilli also pass by inhalation into the lung, but the power of resistance of healthy mucous membrane is considerable. Infection through mucous membranes, such as that of the nose, &c., is also possible; whether in this case a minute abrasion is necessary has not yet been decided. Painting the eye of a susceptible animal has occasionally caused plague; in such an experiment, however, it is impossible to eliminate the possibility of the presence of some abrasion, made by the paint brush, by which poison can enter. Clothes are generally infected by the excretions of the patient himself. Whether the poison can

multiply in the house floor is also a question which has not yet been settled, but where the floor is strewn or saturated with organic matter, and where there is a certain amount of dampness and heat, it is possible that the multiplication of the poison may occur. The retention of the infecting power of the floor must depend upon the dampness of its soil and dust; dryness certainly reduces the chances of indirect infection in many places where humidity is absent from the atmosphere. There will always be a greater tendency for the plague to spread in a hot moist climate than there will be in a hot dry climate.

Pneumonic infection has always been looked on as the chief mode of infection in times past, but such a position is no longer tenable in face of the evidence now at disposal. No doubt the percentage of cases infected in this fashion must vary in different epidemics according to the habits of cleanliness, nature of clothing, presence or absence of opportunities for inoculation, &c., and probably the best proof that we have of this method of infection is to be found in the results of the experiments of the Russian Commission, who introduced plague cultures into the tracheæ of monkeys and caused death of the animals by plague. If the possibility of slight abrasion could be eliminated the evidence would be convincing; but when it is borne in mind that diphtheria bacilli introduced into a perfectly sound and healthy trachea of a rabbit have little power of setting up diphtheria poisoning, whilst the same bacillus introduced into a trachea with a slightly injured or inflamed mucous membrane readily sets up the disease, this factor of the condition of mucous membrane in plague cannot be too strongly insisted upon. Certainly the old idea of infection by breathing a plague "atmosphere" must be discarded, unless one grants that the plague "atmosphere" consists of stirred up plague-infected dust and dirt. The extraordinary immunity of hospital attendants during the plague epidemics of the last three years should convince the greatest supporters of the "plague-air" infection theory that breathing the same atmosphere as plague patients is insufficient to cause infection. Even in the case of infection in hospitals the infective agent is generally introduced by accident or carelessness in nursing. Further than this, it has been the general experience that the search parties in towns have almost invariably escaped; whilst on the other hand the cleaning up party and the disinfecting party while at work have frequently suffered considerably from infection. On the question of intestinal infection different opinions are held. Wilm who has fed animals on food infected by culture, believes that they die from plague set up by intestinal infection; Yersin fed animals on plague tissue and obtained similar results. I believe, however, that here we have probably to do with mouth or tonsillar infection rather than with direct intestinal infection. Kitasato and Wilm hold that they have succeeded, by means of a tube, in passing down plague culture into the stomach and the animal has died of plague. Wysokovitch and Tablotney repeating these experiments on monkeys failed to induce death. These latter observers conclude that all the lesions they discovered in the abdomen—inflammatory hæmorrhagic patches, with sometimes erosions of the intestinal wall, with enlargement and slight inflammation of the mesenteric glands, which contain very few bacilli—are secondary, and due to intoxication of the patient by the poison. I have seen, however, many cases in which the mesenteric glands have been very greatly enlarged, and similar in all respects to the primary buboes met with in the groin or axilla. None of the experiments hitherto devised and carried out, it must be admitted, appear to me to solve this question of direct intestinal infection. It is quite possible, from the very close connection of the thoracic and abdominal lymphatics, that the latter in severe cases of infection may have several glands partaking of the primary inflammation, and even the propinquity of enlarged retro-peritoneal glands may lead to "contact" inflammation of the mesenteric glands, the inflammatory mischief extending directly without the intervention of lymphatic channels. It may be, however, that as in tubercle there may be a kind of collateral or even reversed lymph circulation between the retro-peritoneal and lymphatic glands.

In dealing with the question of mesenteric and intestinal infection it must be remembered that opportunities for such a mode of transmission must be very rare, and even allowing that the feeding experiments are to be accepted as accurate, this mode of infection is still comparatively unimportant, as the conditions unfavourable to the life of the plague bacillus in food, in water, &c.,

have always to be taken into account; for example, the life of the bacillus when transferred to water is so short that very few opportunities are afforded for infection in this fashion, whilst the cooking to which meat is usually subjected prevents infection by that means. Indeed, as has already been insisted, infection of any material which is to be eaten or drunk must be extremely rare. Even the possible infection of the pig could seldom lead to infection of the human subject, as the flesh of this animal is usually cooked before it is eaten in oriental countries. Intestinal infection should certainly only occur very rarely in the ordinary conditions of life. The introduction of plague material into the stomach or œsophagus of an animal by means of a glass rod is so artificial a method of infection that too much, I think, has been made by Wilm, Kitasato, Yersin, and others of this mode of infection. In feeding on plague tissues, a far more common mode of infection would be by mouth abrasions or tonsillar inoculation, whilst dust and dirt carried to the tonsils by food would seem to be a much more fruitful source of infection. It must be borne in mind also, taking tubercle as an analogy, that invasion of the tonsils by tubercle is of much more importance than actual œsophageal, gastric or intestinal infection. Plague infection by food must therefore at present be looked upon as usually experimental or accidental or through the tonsils, and could then only happen where the surroundings are of the filthiest. Infection through water has been described by Wilm as of undoubted occurrence, but experimental evidence points to the fact that plague bacilli do not multiply in water, and it is stated that when this medium is infected by the addition of plague culture, the mixture loses all power of causing infection within a very short time. Some have even placed the period of death of the bacillus in water as being within 48 hours, distilled water and polluted water acting in much the same manner. That the disease is primarily a soil disease is certainly borne out neither by observation nor experiment. Takaki and I carried out bacteriological experiments in Hong Kong by which we were able to prove that even in houses in which the earthen floors had been severely infected, no cases of plague infection could be obtained, and later experiments on the artificial infection of earth with a culture of the plague bacillus have shown that the mixture of earth and bacilli loses its infecting power, sometimes in a couple of days. Indeed, there has been no proof forthcoming so far that the plague bacillus has ever been found below the surface of the earth.

Conveyance of infection by clothing.—That clothes can carry the disease has been proved beyond doubt, but such mode of spread is certainly not of common occurrence during an epidemic, this for several reasons. The clothes which are most infected are usually worn by the patient, and when that patient dies, destruction by fire, even amongst the poorest classes, is often had recourse to; and in an epidemic where Europeans are at work, the disinfection and burning of all clothing must necessarily interfere with any spread of the disease by this method. In several instances, however, the spread of plague through the agency of infected clothing may be cited. At Vetlianka, in 1879, a girl of ten years of age opened a box of clothing which had come from a house in which all the inhabitants had died two months previously. She opened the box, took out the clothing, worked upon it, and contracted the disease, which made its appearance four days later. In Hong Kong, in 1894, a Chinese boy of one of the volunteer search parties was admitted to the hospital suffering from plague. This boy stayed far away from any of the infected areas, and no communication of any sort with the town could be proved; the only traceable way in which he could have contracted the disease was by dust inhaled whilst he was cleaning the clothes which his master regularly wore during his work in the infected areas, or by inoculation from handling them. In 1896, at Hong Kong, the washerman at the plague hospital died of plague; here the only possible source and period of infection, other than the bedding and clothing with which he had to work, was for a few hours eleven days before the commencement of the attack of the disease when he left the hospital, and even then it could not be proved that he had gone near any infected area. That the infection may also be carried by the clothing or personal baggage of people who themselves remain in health is probable; the following case certainly seems to point to this possibility. In the early part of February 1897, three men,

some of whose friends had died from the plague in Bombay, arrived at Ahmedabad from that city and stayed in the house of a friend outside the city wall. Up to this time there had been no case of plague in Ahmedabad. Three days later, still perfectly healthy, they left for a village in Baroda, where they were afterwards discovered perfectly well. Two days after they had left Ahmedabad, four of the inmates of the house in which they had stayed were attacked with plague. In this case, no other source of infection could be traced. At another village, Akhada, several people returned from Bombay bringing with them various goods and chattels. No other people from Bombay arrived in the village at that time, a few days later two of the friends with whom they were staying were stricken with plague. In this case, one is forced to the conclusion that the infection must have been carried by the clothing. Laboratory experiments on the artificial infection of clothing indicate that as a rule the power of infection is lost in about ten days, but the question as to how long the infecting medium may retain its activity in clothes in ordinary circumstances depends on a variety of conditions:—(1) the amount of soiling; (2) the amount of moisture in the atmosphere; (3) the way in which the clothes are packed, especially as this may affect the amount of exposure to air and sunlight. Experiments with infected clothing, in which the bacilli appear to die very rapidly, will always remain a difficulty, but with the noted instances on record, where clothing has carried infection even after the lapse of some considerable time, it is necessary in practice to take the most stringent precautions to ensure the disinfection or destruction of all clothing coming from infected people, and all infected clothing coming from an infected area.

Infection of and by grain (?)—The question of infection by grain has on many occasions been brought into special prominence, and the experiments of Mr. Hankin in India have some bearing on this point. He has found that artificially infected grain usually loses its infecting power in less than eight days. In considering this question, however, it is necessary to demonstrate that grain becomes affected naturally. The examination of grain which has not been artificially infected has hitherto always led to negative results, and until we can find out infecting power in grain not artificially infected, it is scarcely necessary to press the point. It is certainly impossible to arrive at any very definite conclusion at present on this matter.

In practice in dealing with plague, attention is claimed by so much that is of undoubted importance in connection with the following well-known facts, that for the present these minor channels of infection, though matters for careful observation and experiment, should not be allowed to distract attention from the following:—(1) That man gives off the virus by his excretions; (2) that he infects his neighbours directly or indirectly from infection of floors, clothes, or contents of the house and by various "carriers"; (3) at the same time he may also infect rats through the same media, the rats may then infect a house in a fresh locality of the town or village and so lead to further infection of men. The further infection is often of a more severe type than the case which was the original source of infection. The latter part of this statement (3) is again one difficult of proof. In Macao, however, several instances came under my notice where I had little doubt that some such method of infection played a part. In dealing with all these questions concerning infected cases, it is usually very difficult to obtain anything like complete evidence that communication with man has not occurred. In one house, however, where isolation had otherwise been carefully maintained, rats were found to have entered the house and to have died of the plague; they, in turn, had evidently brought about the infection of two Chinese servants who certainly had not held communication with the outside world for some considerable time. The infection of rats usually follows infection of a distant locality by men. Nowhere has this been more decidedly proved than during the late epidemic in India, where the infection of the rats has unfortunately followed the introduction by man, from a primary seat of infection situated at considerable distances from the secondary area of infection. So strong is the evidence of infection of and by rats that I am strongly of opinion that even those who do not believe much in this power of infection of houses by rats would remain no longer than they could possibly help in a rat-infested house during a plague period. Although there are usually other means of transmission of the infection,

such as by direct communication of man to man, of man to house, or of house to man, it must always be borne in mind that this infection from rat to man is not only a possible but in many cases a probable method of transmission of the disease; indeed, it has often been noted that when inoculated rats or mice are put into a cage with healthy ones, the latter almost invariably become affected with plague—probably from the excretions of the former. What better proof can be had of the possibility of spread of the disease by rats? Substitute a room for a cage and put man and rats into it—as both are susceptible to the disease the result will probably be the same. Rats may convey infection from infected burrows on their feet or fur; they also become infected by eating each other. When dying they usually leave their holes and run about the rooms of a house and then die. Carelessness in dealing with or handling them, especially in the filthy surroundings and associated with the dirty habits of these houses along with the possible convection by vermin, must all necessarily be in favour of the infection being carried to man. The amount of such infection spread by rats cannot be gauged. That the spread can take place must be admitted, but, as already pointed out, in this connection much must depend on surrounding circumstances as to whether the spread be extensive in area and amount or not. For instance, a dirty part of a town which is thickly infested with these animals, and where the houses are filthy as regards their internal condition, would naturally attract attention as a suitable place in which to look for the spread of infection in this manner, and it is exactly under these conditions and in these circumstances that we meet with rapid and extensive spread of the disease not only in India but in China and elsewhere.

The-so-called "latent period."—A point that has sometimes been made too much of is the fact that a considerable "latent period" has elapsed between the time of the introduction of the disease into the locality and its becoming seriously or widely epidemic. Such a latent period as is only natural from the method of infection has often been noted; at the same time many cases may be introduced into a fresh locality, and yet no infection occur, for the simple reason that many cases do not give off infective material, whilst others again give off very little. When the so-called latent period is spoken of, this fact must be carefully borne in mind. Many imported cases have led to the occurrence of no further cases around them, whilst, on the other hand, in certain instances one imported case has given rise to a small epidemic. There are many cases of plague in which the patient gives off no excretions at all, consequently the chance of infecting the people round him is *nil*. It does not follow that because one case is imported that an epidemic must spread from it. If it did, there would have been many more epidemics to deal with in Bombay Presidency than really occurred. It may now be accepted as an undoubted fact that the danger of infection only becomes marked when the disease has become septicæmic, that is, when the bacilli, instead of being localised in the glands and tissues, make their way into the blood, and thence into the excretions and secretions. Many plague patients never give off any excretions or secretions from the time that they are attacked by the disease till the time of their death. Here also the danger of infection remains at a minimum. The solution of this latent period, then, is that in the great majority of cases, where ultimate epidemics have arisen, the real infecting case has arrived at a later date than the primary importation. There are two distinct types of plague cases, one in which the natural secretions are inhibited or not thrown off or are not specially active, and the other in which the lungs, kidneys, or bowel may be intensely affected, and large quantities of infecting secretions, more especially of sputum, of a most virulent character may be given off. The former type is not especially dangerous to people round about, whilst the latter is infectious and contagious in the very highest degree; it can never be foretold when a case of the former type will run into one of the latter. While sometimes ten cases of the Hong Kong type of disease would not be sufficient to start an epidemic, one bad pneumonic case of what has hitherto been the prevailing Indian type might set a village ablaze with plague in a very short time. Plague, to commence with, is a slowly progressive disease, but, when let alone, a time comes in about six weeks when the spread seems to be by more than geometrical progression; this was especially well marked in

Bombay and Poona. It is also notable that in many places,—Hong Kong, Bombay, Canton, Macao, Poona, for example,—this rapid increase has followed immediately upon a great spread of the disease amongst rats.

Influence of Climate, &c.—Heat and moisture have of course a certain influence in determining the spread of the disease; the best proof of this must necessarily be laboratory evidence, which shows that a temperature between 80° and 100° Fahr. produces the most rapid growth in a culture tube where moisture is present.

Where the tissues and fluids of men are the culture media of the plague bacillus, and where direct and indirect infection from man to man is so easy, it must be evident that plague, when once introduced, may spread very rapidly and widely without external heat and moisture having much effect. Where a hot dry state of the atmosphere prevails, one can only assume that indirect infection, such as from clothes, infected houses, &c., must undoubtedly be rarer, as in a very dry state dessication and destruction of the bacilli ensue in from one to four days. The spread of the disease appears to be independent of external heat as may be gathered from the outbreak at Sukkur, where the disease spread rapidly, the temperature being between 110° and 120° Fahr., and the atmosphere very dry. The epidemic at Poona, too, spread there in the hottest and driest period of the year. A glance at the map, however, shows at once that the spread of the disease in the Bombay Presidency was principally on the coast line; this may be partly accounted for by the fact that the moisture in districts near the sea may favour the retention of vitality by the poison, so that indirect infection is thus made more easy, but some of this spread on the sea coast must be put down to the fact that the races of fishermen who inhabit various districts move about very freely; indeed, a large spread of the disease was traced to the migration of these people from place to place, from villages which were in a state of virulent infection. In many villages in Thana district, Colaba and Surat, the disease was certainly usually traceable to this cause.

Within the last three years plague has flourished at all temperatures ranging between 50° and 120° Fahr., and in very dry and very moist climates, where we know that man with his equable and regulated temperature is the main cultivation ground, this is the only thing to be expected; in fact, it is an important part of the proof that man is the main carrier. It must be borne in mind, however, that as the plague bacillus is so easily killed by dessication, and as a hot dry climate can bring about this dessication in a few hours, the chance of indirect infection in hot dry climates must be considerably lessened.

Infection from dust or soil.—In Hong Kong, the soldiers who were attacked by plague were in the cleansing squads, and were well booted, but worked with trousers open at the bottom. In India the military parties who assisted in this work were ordered to wear putties to prevent plague-infected dust and animals from coming in contact with their legs, with the result that none of those engaged in this work became infected, and that, too, amongst probably eight or ten times more soldiers than were doing the work in Hong Kong; where the soldiers in Hong Kong were numbered by hundreds, in India they were numbered by thousands. One reason that so much stress has been laid on the question of infection from the soil is that in former days it was stated that people living on the ground floor were usually infected first. Where there is only one floor in a house, or at least where so many houses only contain one floor, as in Oriental countries, it of course follows that the majority of cases must occur on such floor. In Hong Kong and Bombay especially, where the conditions are somewhat different, cases have occurred on any and every floor, and if there has been a preference for any particular floor, it has not been for the ground floor, where there is more fresh air, and where the shop is usually situated, and therefore where contact does not usually take place; it is rather in the sleeping chamber where the general facilities for the spread of the disease would naturally be most marked, and where, under ordinary circumstances, infection would be most liable to take place. Too much stress is sometimes laid on the fact that plague usually spreads most rapidly when the surroundings are filthy. It does, of course, spread very rapidly under these conditions, but it can also spread in the cleanest house, overcrowding and certain peculiar habits being in many cases of the greatest importance in

spreading it. The habit of spitting over the floor, so common in India, has been alluded to; but another equally important one in spreading infection is the habit of people who are attending the sick, of wiping away sputum and expectoration with their bare hands, and not subsequently cleansing them. This habit is assisted by one almost as dirty, that is the washing of the anus after defæcation, which is universal throughout India. This habit in itself is cleanly enough, but it loses this virtue from the fact that the operators do not disinfect their hands afterwards. In one hospital I saw a woman doing this to a plague-stricken child, and it was a curious coincidence that the woman took ill with plague three days after, with an axillary bubo, and died in another two days. She might of course have previously been infected as she was only removed from a plague-infected house two days before, that is, five days in all for an incubation period. In Salazi at Cutch Mandvi, many of the plague houses were beautifully clean, in fact, could not have been made cleaner by any process, yet a large number of the inhabitants of these perished; here I think that indirect infection was infrequent, and that the people must have been infected directly from the sick. The influence of dirty houses, badly ventilated, and often without light, has been so often apparent that mere passing mention of the fact need only be made here; it should be remembered, however, that it is not the universal rule.

To sum up, it may be said that the following are the most important items in the spread of plague:—

- (1.) Filthy habits of the people, such as spitting over the floor, and others mentioned above.
- (2.) Filthy houses.
- (3.) Overcrowding and consequent rapid increase of contagious disease when once imported.
- (4.) Presence of rats, insects, and other vermin.
- (5.) The naked condition of the people going about, such people presenting almost unlimited opportunities for the entrance into their tissues of plague poison by inoculation and through abrasions.
- (6.) Pollution of soil and houses with the excretions of man and animals.
- (7.) Filthy clothing and absence of bodily hygiene.
- (8.) Badly ventilated and dark dwellings.
- (9.) Absence of any care in attendance to the sick.

Under these conditions it may be readily appreciated how plague which multiplies so rapidly, which has such a short incubation period, which under these conditions is so infectious, which has so vast an area of entry, may, when once imported, spread with the greatest ease. It will at once be seen that man and rats are the two main factors which have to be dealt with in spreading plague. All history proves, however, that infection of places at a distance from the seat of the epidemic has occurred through the introduction by man or man's infected clothing. It is against common sense to think that rats can be the vehicle of transmission of the poison over these long distances in those cases in which they must travel on their own feet between the two places. Man is the principal carrier of plague virus over long distances; from his excretions he infects clothes, house, friends, and rats, which latter are always secondarily affected, and it may now be accepted as proved that where the cases of plague in human beings are treated early enough, and with proper methods of disinfection, rats will not be infected. Plague thus spreads when man travels by train, ship, boat, and other conveyance or on foot. Rats, however, have to do with the local spread of the disease, and also probably with increase of virulence of the microbe, owing to passage through these animals leading to exaltation of the activity of the organisms. It has been an almost universal experience that where plague has been introduced into distant places, it has been through the direct agency of man or his belongings, and that, on the other hand, where it has been possible to prevent the spread of the disease in any given locality, this has been brought about before a general infection of rats has taken place. As already pointed out, this infection of rats occurred in Hong Kong, Canton, Bombay, Poona, and Kurachee, and time after time I have been able to synchronise a most rapid increase of virulent plague with or immediately following a heavy mortality amongst rats. This only explains what has been observed in earlier epidemics of plague where it has been thought that rats have been affected before there has been an outbreak amongst human beings.

Pestis Minor.—Some writers have described a form of glandular disease under the name *Pestis Minor*, which they assert precedes an outbreak of true plague. Cases in Russia and Mesopotamia of late years have given rise to this same general impression. In Hong Kong there was an occurrence of no such cases, and in India the most careful inquiries carried out on all sides lead me to the conclusion that no such condition prevailed anywhere in the Bombay Presidency. I doubt whether the mild non-septicæmic cases of plague reported are infectious, even in the slightest degree. So far as my own experience goes, recent epidemics have always been caused by the introduction of a virulent plague bacillus, and I do not at present believe in a polymorphic plague organism further than that its *form* may be slightly modified on artificial culture media, though, after a series of “passages” through such media, its *virulence* may be considerably diminished. This, however, is soon raised by passage of the organism through guinea pigs to a virulence sufficient to kill a man or rat of plague, just as surely as would the primary virulent culture. In any case, after an epidemic has commenced, this question of attenuation or modification does not require much consideration. Further bacteriological experiments will probably show that if any of these cases of so-called *Pestis Minor* are really plague, they, at any rate, are not infectious. It is necessary also to find that something resembling the plague bacillus and answering to its serum tests can be extracted from such cases before asserting that there is any connection between glandular enlargements and plague. No one, so far as I know, has found such a bacillus.

MEASURES NECESSARY FOR SUPPRESSION OF PLAGUE.

The measures considered necessary (set forth on page 3 of this report) are only briefly mentioned here, as they are taken in detail later on:—

1. (a) The erection of commodious hospitals on suitable sites for the isolation of the sick.

(b) The appointment to these hospitals of a requisite staff of doctors, nurses, and attendants, and their equipment with medical appliances and stores of disinfectants, and with all necessary sanitary and commissariat arrangements.

(c) The erection of separate hospitals, where necessary, for those castes or creeds whose tenets forbid association with any but their own sect.

(d) The maintenance of sanitary supervision by the constituted authorities of all private hospitals erected or to be erected by various castes.

2. The construction of segregation camps in convenient proximity to the plague hospitals for the medical inspection, observation, and sanitary supervision of persons who have been exposed to the infection of plague.

3. (a) The organisation of house to house search parties whose duty it shall be to detect cases of plague in the early stage, as also those suffering from fever and suspected to be suffering from the disease, and to remove them immediately to hospital.

(b) The removal to a segregation camp for observation purposes of persons occupying the same room as the sick, or any person who may reasonably be suspected of having been exposed to infection.

4. The organisation of an efficient registration department to record accurately cases of, and deaths from, plague in the various districts.

5. The organisation of a system of thorough corpse inspection which in various phases of an epidemic is absolutely necessary.

6. The training in the larger plague centres of men who would form a reserve, available, if necessary, for use in the out-lying districts, where sanitary staffs are formed for medical inspection and disinfection of people and their belongings leaving infected areas.

7. Suitable places, where not already provided for the speedy disposal of the dead, either by burial or burning, to be obtained by the burial staff.

8. The organisation and training of disinfecting squads provided with all the materials and appliances necessary for efficient disinfection of houses and their contents.

9. The destruction of as many rats as possible, especially in places where they are numerous.

Early attention was called to the necessity for this destruction of as many rats as possible, but, as will be explained, the difficulties met with have hitherto been insurmountable. In a town where sewers are plentiful the attempt might be made to kill them in the sewers, but Bombay was the only sewered town where plague was rampant, and there the rats were all dead. The task of killing rats in other Indian towns would be a much more difficult matter than it would be in any place in England.

All these arrangements involved a very large general increase of the existing staffs, which, at first, were quite inadequate, as also the creation of many new organisations in different centres. The above measures were the ideal kept in view, and were to be carried out as far as possible. In many cases, however, the real fell far short of the ideal.

With regard to (6), the strengthening of the native medical element, a most important matter, was effected by getting the fourth year medical students at the Grant Medical College hurried through their examinations, a task expedited by the courtesy of Surgeon-Lieutenant-Colonel Hatch and the College authorities. The extra staffs for outlying districts were mostly procured through General Gatacre and his Committee, whilst disinfectants were also supplied through the same agency until Government procured a large supply from England.

RESULTS OF MEASURES BEING CARRIED OUT.

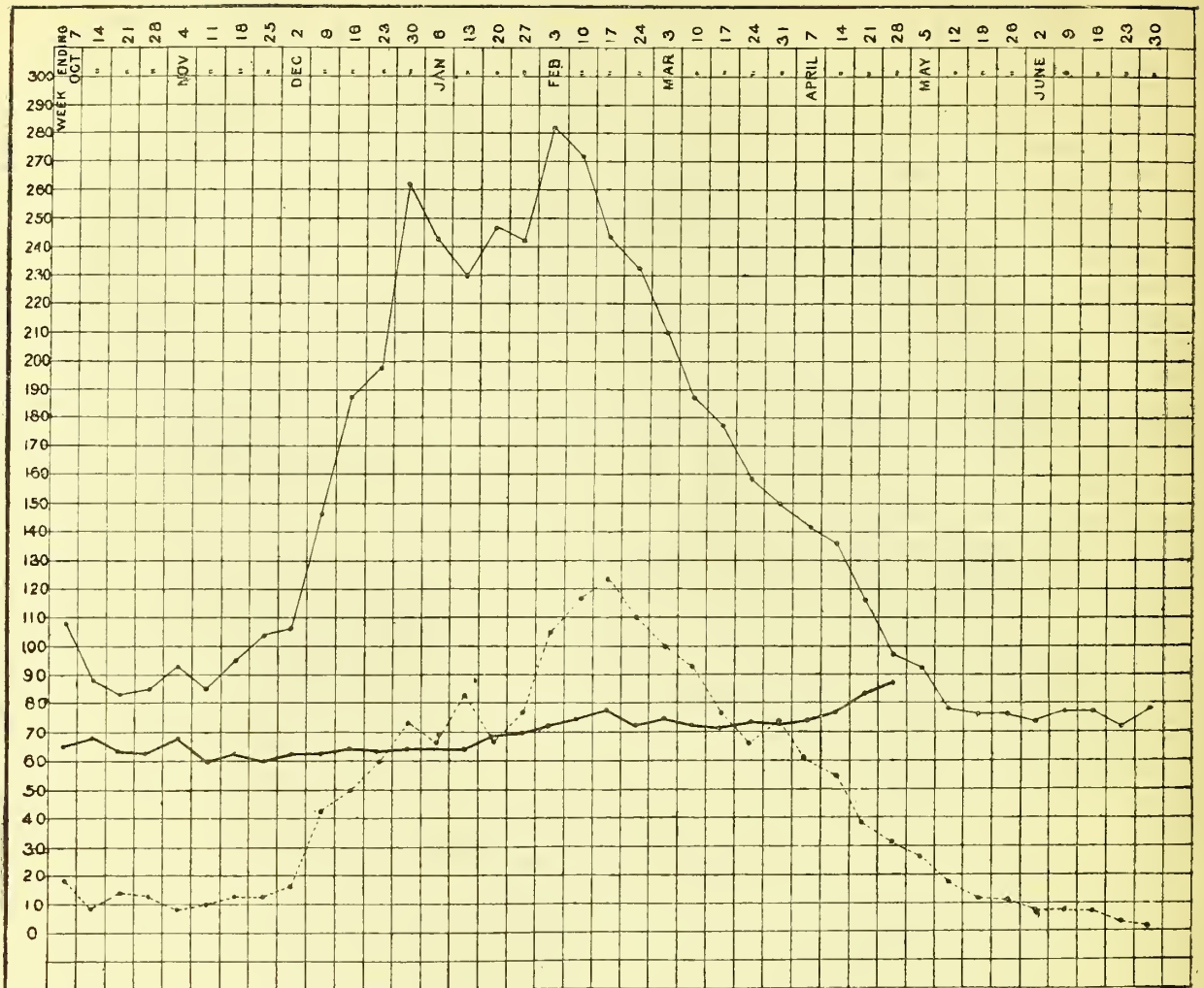
Bombay.

The results in Bombay are graphically given in the appended chart. It will be seen that the fall of the actual number of deaths began in the week ending 16th February, although the rate per mille per annum kept up till about the middle of March. The decline continued uninterruptedly until the end of April, when the death-rate came down to normal.

Thorough search for cases, on which success generally depends, was early instituted, and the following rough figures show its effect. The average death-rate for the city is assumed to be 75 per diem, a high estimate considering the diminished population, and as the city was free from other epidemic influences it may reasonably be supposed that the large increase was certainly due to plague.

| | Plague Attacks reported. | Plague Deaths reported. | Total Mortality. | Average Death-rate. | Cases not reported or Undiscovered. |
|----------------|--------------------------------|-------------------------------|---------------------|------------------------|---|
| January - - - | 2,374 | 1,835 | 7,425 | 2,275 | Over 3,000 |
| February - - - | 3,172 | 3,072 | 6,879 | 2,100 | „ 1,600 |
| March - - - | 2,495 | 2,266 | 5,398 | 2,275 | „ 600 |
| April - - - | 1,418 | 1,277 | 3,618 | 2,100 | „ 100 |
| May - - - | 448 | 328 | 2,418 | 2,170 | — |

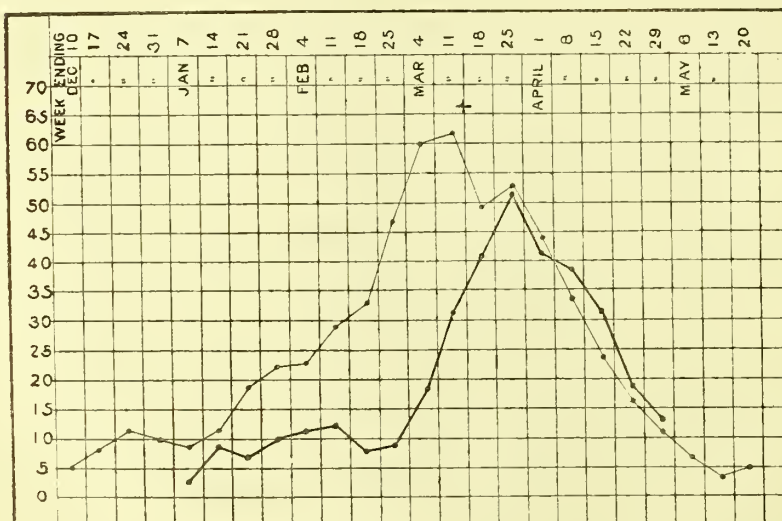
These figures of excess can be accepted as correct only on the supposition that all discovered cases died; probably, however, about 15 per cent. of the cases recovered and were thus not recorded in the total mortality. The number of undiscovered cases should therefore be considerably raised proportionately.



The thick black line shows the daily normal mortality of the city of Bombay; the thin continuous line shows the actual mortality of Bombay registered during the epidemic; whilst the dotted line shows the number of ague cases reported daily during the epidemic.

Poona.

The first recorded case of plague in Poona occurred on 19th December 1896. The disease progressed slowly until well on into February, then increased rapidly



until the total mortality from all causes reached 82 on the 10th March. The population of the city was estimated at about 120,000 on 1st January 1897. The mortality statistics for December and January were so irregular that no confidence can be placed in their

correctness as far as daily figures go; on some days no death would be reported, and on others as many as 30 or 40. Assuming that the total number of deaths is given correctly, and an average struck for each day from that day's return and the two days before and after, the accompanying chart of total mortality will give an idea of the rate of increase of the disease. This "average" system is taken up to 7th March, after which date the daily figures are taken as being approximately correct.

This serious condition of affairs in Poona demanded early interference, the fear of an advance of the disease eastwards in the Deccan being an additional reason for at once starting operations on an extensive and thorough scale. On receiving a report from Surgeon-Captain Beveridge as to the condition of the town, a statement of the full organisation required was given to Mr. Rand on 27th February, but work was not commenced till 13th March, owing to the want of a sufficiency of ladies to assist the search parties. After the latter date, work was carried on so thoroughly that plague cases were well under control on 1st May, and the epidemic rapidly declined, so that in the week ending 7th May only 26 cases occurred, whilst after 13th May the cases only averaged one-and-a-half daily till the end of the month. Thus the epidemic was arrested well within two months from the adoption of thorough measures for stamping it out.

Before the house-to-house visitation was left off, a thorough system of corpse inspection was initiated, and was being kept up when we left Poona on 14th July.

The efficiency of the house-to-house search is shown by the figures in the table given below. Assuming that the mortality from other causes in the city remained at the average of former years, or rather below it, during February over 550 deaths from plague must have gone undetected; during March over 300; whilst in April, when 643 deaths occurred, 593 plague cases were discovered by the search parties with 416 deaths and very few, if any, cases could have gone undiscovered.

| | Plague Attacks reported. | Plague Deaths reported. | Total Mortality. |
|--------------|--------------------------|-------------------------|------------------|
| December - - | 4 | 4 | 270 |
| January - - | 101 | 95 | 497 |
| February - - | 203 | 172 | 1,009 |
| March - - | 1,098 | 756 | 1,656 |
| April - - | 593 | 416 | 643 |
| May - - | 63 | 50 | 192 |
| June* - - | 9 | 7 | 390† |

* Last case in city occurred on 17th June.

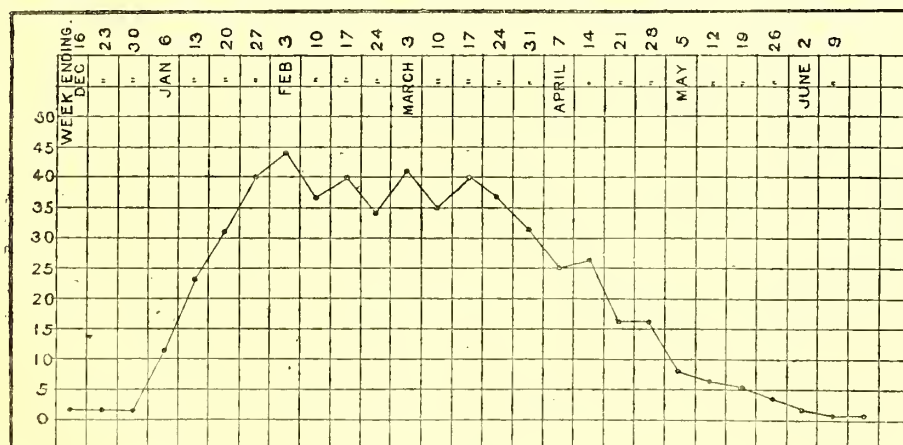
† High death-rate due to an epidemic of cholera, as many as 25 cases per diem occurring towards end of month.

Poona was recognised as a test case as far as the utility of these measures was concerned; the results obtained certainly fully justify the anticipations formed.

In the chart the thick black line shows the number of plague cases reported, whilst the thin line shows the actual total mortality reported. The cross denotes when operations were commenced on a thorough scale.

Karachi.

The plague was first recognised in the town of Karachi on 10th December 1896, the infection having undoubtedly been imported from Bombay, between



which city and Karachi at the time of the exodus from the stricken capital of the Presidency there was frequent communication by sea. On 25th December six cases were reported, on 3rd January 16, and on 10th January 43 cases. When the disease was recognised, measures for its suppression

were at once put in force. The sanitary and medical staffs were considerably augmented, cleansing operations were carried out on a large scale, and plague hospitals were established in various parts of the town, but on 21st March neither compulsory isolation of the sick nor segregation of suspects had been thoroughly carried out. The experiment of moving a large number of people from a densely infected part of the town into a health camp on the Trans-Lyeri—a large plain—was begun in the latter part of January and carried on during February and March, but as shown by the annexed chart, no diminution of the disease took place. The measures possibly prevented an increase of the disease, but they were insufficient to bring about its diminution.

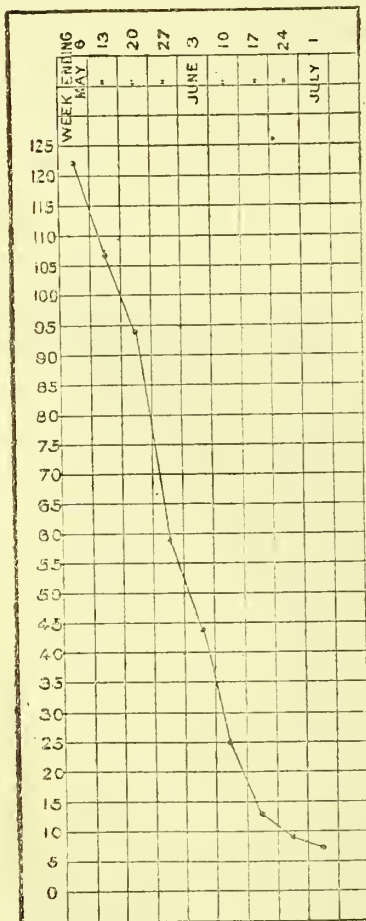
On 20th March Karachi was visited by His Excellency the Governor, when similar measures to those already undertaken in Bombay and Poona were commenced. A complete system of inspection and disinfection was established, both for those arriving at and departing from Karachi by land and sea. The passengers by sea were impounded for three days, during which time their baggage and clothing underwent thorough disinfection, and they themselves were subjected to daily medical inspection. The land inspection with disinfection was carried out on similar lines, and every outgoing and incoming passenger had to alight for inspection at a station some miles distant from the town. The detention in this case, however, was limited to twelve hours. The camps of infected people on the Trans-Lyeri were placed under strict supervision, and no persons were transported from infected parts of the town unless the disinfection of clothes had been carried out.

The charts show that the measures adopted were successful. At the end of April the daily average of cases had fallen from 40 to 17, and by the end of May the epidemic was well under control.

As at Poona, a careful inspection of every dead body was instituted before house-to-house visitation ceased.

Cutch Mandvi.

Orders to proceed to Cutch Mandvi to report on the plague situation there were received on 17th April; on arriving there on 24th April a very severe epidemic was found to be prevalent. Although it was reported that the disease had only existed for a little over a month, it is almost certain that it had been in existence undisturbed for at least double that period. The town had been reduced by emigration from a population of about 45,000 to 12,000, and the death-rate was even now very high, the first two days of correct statistics showing 113 and 139 deaths. The sanitary state of the town was very bad; most of the officials were helpless because they did not know what to do, and the people were panic stricken, so much so that labour was not procurable.



Correct death returns were procured by posting sentries at burning ghats and burial grounds, and plague measures were begun with the limited staff available. On 1st May Surgeon-Lieutenant-Colonel Wilkins arrived from Bombay with a staff to assist, and further help was sent as it could be obtained. The accompanying chart shows the course of the epidemic after commencement of operations, the total mortality being used for this purpose.

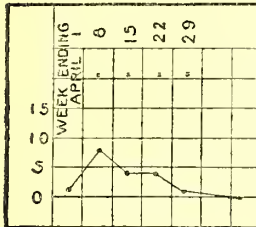
As the exodus of people from the town took place principally in a north-western direction, the villages on that side became infected. The authorities at Bhuj and the north-eastern villages segregated all arrivals and were successful in preventing the entrance of the disease, at any rate, till 16th July.

In Cutch territory about 150 cases of imported plague were recorded from October to the end of March, and during January, February, and March 40 locally infected cases occurred, the majority occurring at Rawahpur. In Cutch Mandvi itself during the first week of April only eight locally infected cases were reported. As there were about 150 cases occurring per diem at the end of April these last figures must have been incorrect, and the epidemic was probably severe even in March, before the Cutch authorities knew that the mortality was so serious.

Palanpur.

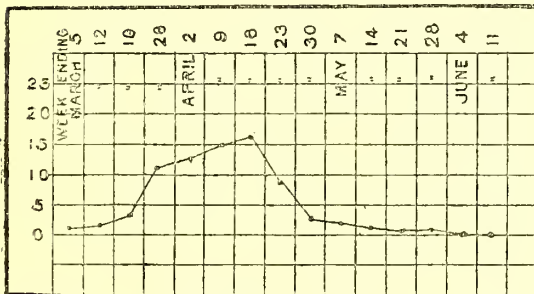
Towards the end of March 1897, an outbreak of plague was reported from the town of Palanpur. The State of Palanpur is situated between Rajputana on the north, and Cutch and Kathiawar on the south, and the population of the capital was reported to be about 22,500 on 1st January 1897. The reports had exaggerated the gravity of the situation, still there were enough cases of plague occurring to cause considerable apprehension of an extensive epidemic. The epidemic had evidently been going on in a mild form for some time, as it often does at the beginning of an outbreak, as from eight to ten cases were occurring daily when the Government inquiries were instituted.

It was impossible to say when the disease was probably introduced and had commenced to spread, as no correct record of deaths could be procured. Surgeon-Captain Cleveland was deputed to take charge of plague operations, and the usual methods were adopted for the suppression of the disease. How successfully these were carried out may be judged by the fact that in three weeks it was stamped out, in spite of the fact that Surgeon-Captain Cleveland had little skilled assistance. The chart gives the average daily number of cases of plague.



Sukkur.

Sukkur, a town in Upper Sind, situated on the Indus, was infected with the plague early in February, the infection being brought to the town from



Kurrachee, as from the latter town large numbers had fled when the disease there assumed epidemic proportions. Sukkur was under the administration of the Commissioner in Sind, and a Plague Committee on the lines of that at Kurrachee was formed, and the measures for the suppression of the plague were organised on a basis similar to that at Kurrachee. The

normal population of Sukkur was 29,000, but the exodus of the people who had a great fear of the plague had reduced the number to 6,000, the remainder having encamped mainly in the neighbourhood. The first case reported occurred in the week ending 13th February, but the date of commencement of spread of the disease must have been somewhere in the week ending 27th February. In the first week in March, the progress of the disease was marked, and by the end of the fourth week the weekly total of cases was 107, the maximum reached during the epidemic. The weekly average for March was 47. During April the incidence of the disease was more severely felt, the weekly average being 58; in the last week, when the influence of the measures set in motion early in April began to be felt, the average was only 18. In the first week of May the epidemic was at an end, though a few cases continued to crop up till the end of June. Although the measures taken in Sukkur were similar to those adopted in Kurrachee, the difficulties to be overcome were greater, owing to the paucity of the European element in the former place; without this element it would have been impossible to put the measures into force. This difficulty was overcome by drafting a detachment of 30 soldiers of the Wiltshire Regiment from

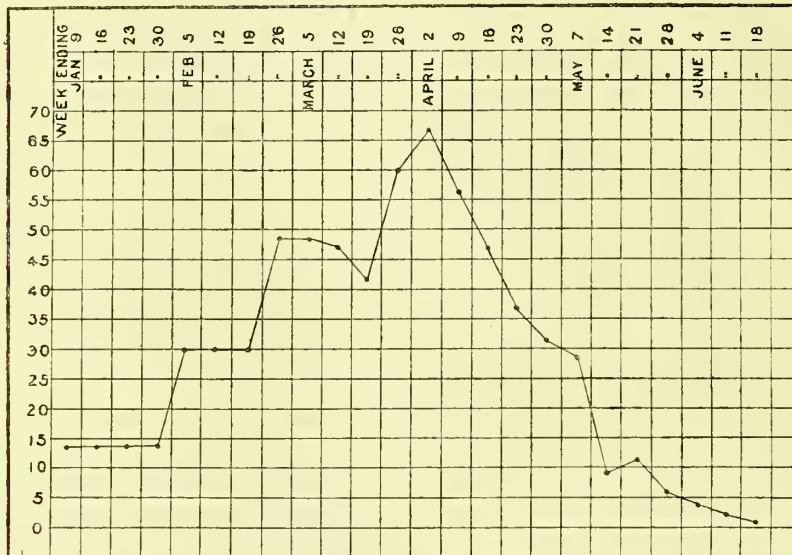
Hyderabad; these men formed the nucleus of the search and disinfecting parties and of the control parties in charge of the segregation camps.

The chart gives the average daily number of cases of plague.

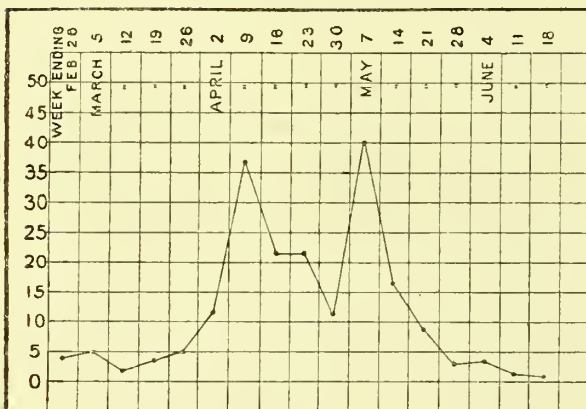
Thana, Colba, and Surat.

The charts for Thana, Colba, and Surat districts are here given. These give the average daily mortality from plague. Kolaba district was worked

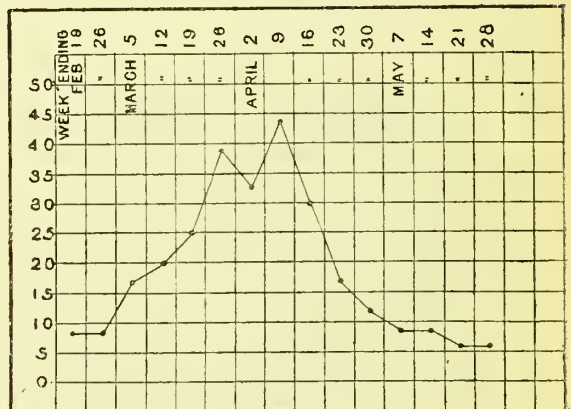
Thana District.



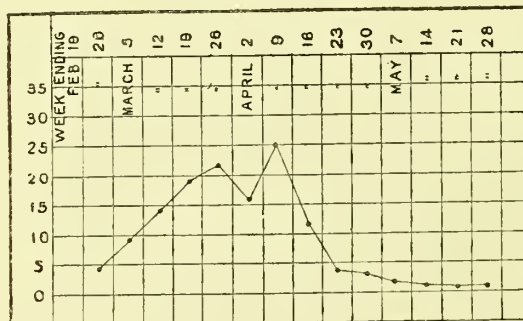
Kolaba District.



Surat District.



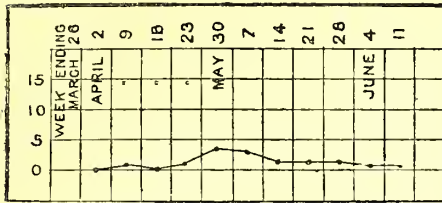
Bulsar Town.



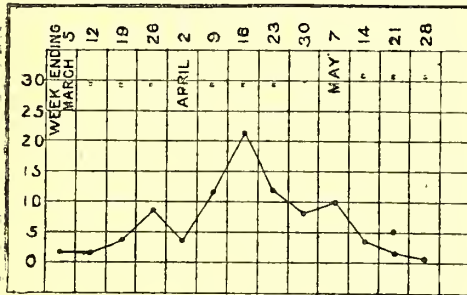
by the Bombay Committee after about 1st May, in consultation with the Collector. Well conducted measures could not at first be carried out in these districts owing to want of men; but as soon as a strong whitewashing gang could be procured from Bombay we were able to deal effectively at least with the disinfection of the place. It must be noted, however, that there had been a dispersal of the inhabitants, and that therefore the danger of infection of those remaining was considerably diminished.

Rohri.

The town of Rohri is separated from Sukkur by a bridge across the Indus and an attempt was made to keep up a quarantine between the two towns by closing the bridge to all traffic. The town was probably infected by boat traffic; prompt measures were at once taken and the disease was stamped out before it reached epidemic proportions. The chart gives average daily plague mortality.

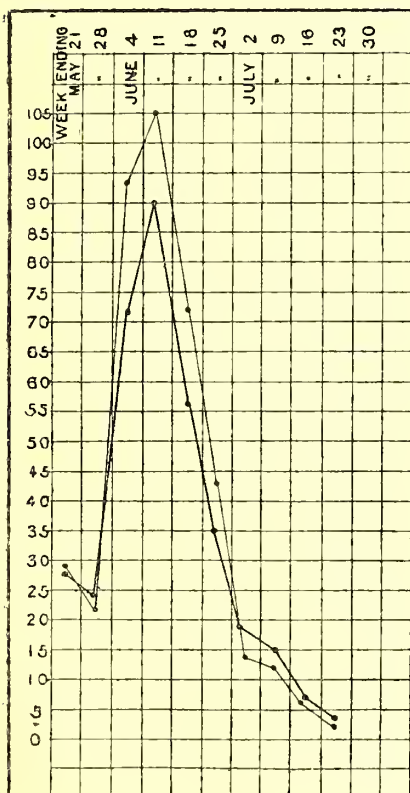
*Hyderabad.*

Hyderabad was infected in the third week of March, the disease spreading from Karachi, with which town it is in direct railway communication. From the town the plague spread into the outlying district. The attached chart shows the total plague mortality for both town and district. Measures for the suppression of the plague were resorted to on its first appearance about the second week in March, but the disease steadily progressed, reaching its acme on the 16th of April. More stringent measures on the lines of the Karachi and Bombay operations were taken towards the end of March and the early part of April, and from the middle of the latter month the disease steadily declined, the epidemic being extinguished by the end of the month.

*Hong Kong.*

As a comparison, the Hong Kong chart of 1894 is here given on the same scale, the thin line showing the number of plague cases discovered, whilst the black line gives the plague mortality. Note that from the commencement of operations, almost every case which remained in the colony must have been discovered.

The remarks on Karachi, Sukkur, Rohri, and Hyderabad are from notes by Surgeon-Major Reade who accompanied His Excellency the Governor of Bombay to Scinde.



DISINFECTION IN PLAGUE.

Disinfection in plague must be considered first as to its necessity. The view that I take on this subject is that, although laboratory experiments show that the plague poison, when freed from dirt and left without the pabulum obtained in man or rat, is soon rendered inert, the epidemiological evidence is so strong regarding the possibility of future recrudescence in infected districts that, in order to ensure safety, as thorough disinfection as possible should be carried out. The outbreaks of plague in Northern India tend to show that there may be "influences" which have some effect in again bringing forth an outbreak of the disease. It is impossible to assume that the plague has gone on perpetually from man to man or from man to rat and *vice versâ* during the world's history, though in what way the poison can lie dormant we do not yet know. It stands to reason, however, that the greater efforts that are made to thoroughly disinfect every infected area, the less chance the disease has of again breaking out.

Artificial infection of clothing shows that the poison usually becomes inert within ten days. Artificial infection of earth results in the infection giving no positive results after the same period, but it is quite possible that the poison may remain virulent in dark dirty houses, which are generally those particularly affected in countries where the disease remains endemic. An infected house in Mazagon, Bombay, was deserted in the beginning of February, and the inmates who escaped did not return to the house until two months later. The house had not been reported as infected to the authorities, and therefore was not disinfected and whitewashed. Nine days after the return of the people several died from plague, but when so much plague was present in Bombay it was quite possible of course that the people were infected outside. Many samples of earth and dust have been collected by different observers from plague-infected houses, but, so far as I am aware, only in one instance has the plague bacillus been detected by Kitasato. The bacteriological proof, however, in a case like this is so difficult that much has to be assumed. Laboratory experiment would show that, even in a dark dirty house, the poison would probably exhaust itself in ten days. This, however, would be a very unsafe premise on which to work, and, as it generally happens that it is necessary to re-occupy houses within a couple of weeks after vacation, it is essential that disinfection should be thoroughly carried out. In the article on infection the question of convection of the disease by clothes has been discussed, as also the possibility of their retaining the poison in a virulent condition for some time, and, although I do not deny that the poison probably dies in a very short period without any special treatment, it is a safer plan with our present knowledge to make certain, by a process of thorough disinfection, that the disease will not recur. Exposure of bacilli on cover glasses to the sun and fresh air results in their virulence being destroyed within twelve hours. Various experimenters have mentioned shorter times, but it is certain that an exposure for some time to sun and fresh air is one of the best house disinfectants that can be applied. The difficulty of carrying this out, however, is very great, and can only be thoroughly effected where the roof of a house can be entirely removed.

Where the poison has to be dealt with in a virulent condition, as in hospital, the free use of disinfectants is inevitable. Here the disinfection of sputum, fæces, and urine must be carried out in the most careful manner. Cases of hospital infection have not been so rare in India as they were in Hong Kong, and one cannot refrain from expressing the opinion that many of these cases of hospital infection are due to carelessness or ignorance. Provided that hospital disinfection is carried out thoroughly, hospital infection must be extremely rare, and where nurses and others are infected in hospital some one is to blame, either the authorities responsible for the arrangements or the person who has become infected. It frequently happened during the epidemic in India, and will happen again, that those responsible for the carrying out of plague measures paid too much attention to the treatment of the patients when they should have been drilling their subordinates in the methods of disinfection. Both of course have their importance, but interest in the

patient frequently swamps the importance of disinfection for the protection of the healthy. If these subordinates are not frequently drilled in disinfection by the medical men, they become careless, however easy the carrying out of their work may be; and hospital authorities would do well to remember that provision of disinfectants in suitable quantities is of far greater importance than the supply of drugs for the dispensary, most of which drugs are seldom really required. This matter is one that is very frequently overlooked even by those who are aware of its importance.

Disinfection of clothing must be looked at from various standpoints. There is the disinfection which is necessary in hospitals and which should be carried out by steam, if possible. As this, however, is not always possible, some of the chemical disinfectants in ordinary use are generally required, and of these carbolic acid solution, 4 per cent., or perchloride of mercury solution, 1 in 1,000, are the most suitable. If these disinfectants are not at hand, the simple process of boiling clothes for twenty minutes or half-an-hour is quite sufficient to kill any plague infection. It is waste of disinfectants to add them to the boiling water. When plague operations on a large scale have to be undertaken, quantities of clothing have frequently to be disinfected on the spot, and this is most economically carried out by treatment with carbolic acid solution or with perchloride of mercury solution. Of course, if steam sterilisers are at hand, these might be used, but it cannot be expected that every town and village can boast the presence of these.

Sometimes a wholesale disinfection of clothing, belonging to people leaving an infected area, may require to be carried out, but in this case it can usually only occur where town measures have fallen far behind. Where every case of plague has been early detected and disinfection promptly carried out, it is easy to see that disinfection on a large scale would be unnecessary; but where a town has been infected for some time, and the people are not prevented from fleeing or are not kept under observation for a certain period, disinfection of clothing and bundles must eventually tend to prevent spread of the disease. In addition, this disinfection usually brings about detention of people for some time under observation, whilst their clothes are being disinfected; and where this detention can be lengthened to four days a most valuable period for observation is obtained, that is, where detention for ordinary observation is disallowed on political grounds. That the disease may be carried in clothes or bundles without infection of man has been proved in India in the instances of the Ahmedabad and Akhada cases, and that other instances of the same kind occur without being detected is more than possible. Wholesale disinfection may be "proximal" or "distal." It may be performed as the people are leaving the infected area as was done at Kurrachee, or it may be performed at the stations at which people from the infected areas alight, as was done at several of the larger towns in the northern part of the Bombay Presidency. In dealing with fugitants from Bombay, where disinfection can be carried out on those leaving the infected areas, it is of course advisable to disinfect, but circumstances such as occurred in the Bombay district may render this impossible. The practical difficulty here would have been so great in the way of procuring accommodation for the people leaving, that it could not have been carried out; by far the better plan would have been to restrict the railway booking. In fact, there must have been a diminution of the facilities for travel if wholesale "proximal" disinfection had been determined on. Cases of infection by clothing which is carried on the backs of people at the time must be very rare, and the practical difficulty of infection by clothing would be easily met by the authorities preventing the removal by rail or road from an infected district of bundles, packages and baggage of all kinds. It would be well, indeed, that no native baggage should be allowed to come into the railway stations at all. This can easily be carried out and would certainly reduce the desire for travel, which often comes to people at epidemic times, when nothing else would induce them to go about; or if this restriction was inadvisable for some very cogent reason it might be possible to demand that all baggage, bundles, &c., should be disinfected at certain depôts under the control of the authorities before being allowed to leave the district, and for which a monetary charge could be levied.

The possibilities of infection of grain by rats, if only for a short period, demand that where rats have been found dead in granaries, the grain should not be removed for a month, or until it has been disinfected by exposure to the sun and air. In the case of grain in bags, where there is no chance of infection of the contents, it is best disinfected by exposing the bags to the sun for three days. Loose grain should be exposed on wooden or stone platforms spread out in thin layers frequently turned over and left exposed to the sun for three days. In India grain shops were very frequently affected, and disinfection of grain naturally formed an important item of the work to be carried out. This infection of grain shops is one of the points on which the grain theorists base their conclusion that the infection is carried by grain, but I have been gradually led to the conclusion that the grain shops simply attract the infected rats and that they in turn infect the people in the house. It is not the grain which infects the rats or the man, it is the grain which brings in the infected rats which then infect the house and man. In the Appendix will be found notes on disinfection which have proved easy of application, and which from experience have proved effectual.

As regards the disinfection of houses and the possibility of a future recurrence of plague therein, some of my own experiences may be of interest. In the non-evacuated areas in Hong Kong in 1894, a large number of houses, from which one or two cases of plague had been removed, were disinfected in a thorough manner by chlorine and lime. A considerable number of these were not re-occupied for about two months, but about half of them were re-occupied within a few days, and in not one single instance did a fresh plague case occur. In 1896, in Hong Kong, thirteen "repeat" cases were reported by the medical officer of health, but these he ascribed to insufficient disinfection. This may have been the cause of such "repeat" cases, but as segregation of suspects in the latter year was only carried out to a very slight extent, this also might have been a contributory cause. Here also the native cunning of the Chinaman and the continuous dodging about to evade the authorities might have led to results which should have been ascribed to something else than merely bad disinfection. In Hong Kong the inhabitants of the house in which a plague case occurs frequently betake themselves to the mainland, a matter of very little consequence to Hong Kong now, when it is surrounded on all sides by plague. Whilst in India, I made numerous official and private inquiries on this subject, and to the question,—“In how many disinfected houses did a case occur after disinfection?” all replies so far have been negative. This occurred in the period embraced in this report, and when the later experiences of the Bombay Presidency are put on record I expect it will be found that repeat cases have been extremely rare where disinfection has been carried out on the lines laid down in the Appendix.

THE MEASURES FOR SUPPRESSION OF PLAGUE.

Before describing some of the measures that are essential to the successful grappling with plague outbreaks, it may be interesting to note briefly the evolution through which measures against plague have gone during the history of this disease in England. Up till the fourteenth century, the air, soil, and fate were made severally and jointly responsible both for the cause and the spread of plague. After the period of the Black Death, increasing knowledge of the disease and wider education led to man being suspected of being the ultimate and main factor in carrying infection about the country. In the sixteenth century a definite plan of operations seems to have been evolved as the result of the experience of the many epidemics which marched through Great Britain during the two previous centuries. In early Elizabethan times some of the measures now considered most necessary in plague treatment were devised and edicts were issued for their carrying out by the Imperial authorities. A *thorough search for cases* of the disease was thus early recognised as one of the most important factors in determining the arrest of

the progress or severity of an epidemic. The *inspection of corpses*, another important branch in the "intelligence" department for procuring information of the disease, was carried out with very great rigour as shown by the fact that the instructions on this head were very sternly worded. In this connection the services of women were called in for the inspection of female bodies, two discreet matrons being appointed at this time for this purpose in each ward of the City of London. Punishment for false information was very severe. So far so good. Where the first error came in was in the steps which followed. Immediately cases were discovered by the search parties or the corpse inspectors, the plague mark was affixed to the door, and the *isolation of sick and suspects* was carried out in the houses, where it is almost needless to add most of the family perished and were thrown out at intervals for removal by the dead carts. This isolation of the sick and suspects was very soon seen to result in the condemning of healthy members of a family to almost certain death. By this time it must be granted that people thoroughly recognised that man was a great agent in transmitting the disease, both in a town and over a long distance. If any further proof of this were wanted, it is to be found in the fact that the most rigid *quarantine* was imposed almost universally throughout the country, but, be it noted, of a most peculiar and varied description. No regular measures seem to have been attempted anywhere. In many towns and cities, for many years in the sixteenth century, the disease was kept out by the simple expedient of erecting gibbets at the main entrances, and hanging everyone suspected of coming from an infected area, the same treatment being meted out to any of the inhabitants who had had any intercourse with such suspects. The city of Aberdeen in particular was noted for the efficacy of its quarantine arrangements on this system, and remained free from plague for over fifty years, whilst the plague was devastating other parts of Scotland. This quarantine was ultimately evaded by a woman, who was smuggled into the city from the infected town of Brechin, for what purpose is not known.

Isolation of the sick in hospitals was first mooted on a regular scale in 1583, to remedy the certainty of infection of the healthy should they be locked up with the sick. However, in those days the differences of opinion on these points seem to have been as great and diverse as they have been in the last few years, with the ultimate result that house isolation remained in full vogue and the plague marched triumphantly on. At this time also the danger of convection of infection by cats, dogs, and swine was reckoned to be considerable, and in this respect these ideas were probably correct, where so many opportunities of prowling about in infected areas presented themselves—cats and dogs were supposed to carry the infection about on their coats. Even in the present day such convection would be more than possible where a state of things existed similar to that of the time now spoken of. The *disposal of the dead*, and the *prevention of contact with plague corpses* were also the subject of strict rules, as well as the general sanitation of the city. The *destruction of infected bedding and clothing* by fire was looked upon as a measure of prime importance. In all rules and official records, however, the importance of the infection of rats and mice seems to have been practically ignored, and the first instance of a regular campaign against the rats seems to have been in 1894 in Canton, where very large numbers were killed. The original premium on their heads had, however, to be reduced, in consequence of the large numbers which were killed and also because some dealers found it a source of profit to import rats from all the country round, which, if alive, were usually kept for breeding purposes. The authorities of Edinburgh in the 16th century, as also in the 17th century, seem to have been the most advanced in their views of plague treatment; they adopted a policy of isolation in special encampments, even on the first appearance of the disease, and had they at that period been in possession of disinfectants and of a knowledge how to use them, it is quite within the bounds of possibility that their energy and concerted action would have sufficed to ward off a severe epidemic from the city. The *care of the excretions from the sick* was also a matter for solicitude in this city, whilst *traffic* over the Forth was *restricted* by the simple expedient of removing the sails from all boats if possible. Dr. Thomas Lodge, so long ago as 1603, saw that it was no use trying to remove the sick when there was no accommodation for them, and recognised in the same

way, as most people do at the present day, the heart-rending effects and hardships of compulsory isolation; but at the same time he was also perfectly cognisant of the fact that nothing else was of any use in stopping the plague. The prevention of the congregation of people at fairs and theatres was yet another subject of rules and in epidemic times such congregation was absolutely forbidden. The use of the military for the restriction of movements of people was frequently had recourse to, but the soldiers were so hopelessly deficient numerically that they could only be used for purposes of guarding the encampments to which the sick at this time began to be taken. On the Continent the contagious character of the disease has been long the only one accepted by the ruling authorities, and the most rigorous measures have been carried out during the last two centuries for the prevention of movement of infected people from infected areas.

Isolation of the Sick.

Seeing that man is the chief carrier and spreader of the disease, it is a matter of the most urgent importance that he should be placed under conditions which will prevent his spreading the disease. Isolation of the sick, however, must be looked at from two different standpoints:—the isolation which is necessary from a sanitary point of view and the isolation which is possible from a social standpoint. In drawing up these measures it should be kept in mind that it is the poor who are to be provided for; within late years, at any rate, it is only amongst the poor, who are necessarily filthy and overcrowded, that the disease has broken out and spread. Again, while it would be quite possible to isolate a rich man and his family in a house in the country, such isolation would be totally out of the question in a crowded quarter of a town. Any byelaw dealing with isolation is perfectly safe when it compels isolation in hospital if necessary, but any such byelaw which does not give power of compulsory removal is sure, in the majority of cases, to lead to further spread of the disease. This point brings up the subject of the possibility of isolation and observation (segregation) in the patients' own houses. This in any case should be discouraged as far as possible; in a crowded town it is sure to lead to further spread of the disease, because (1) it is administratively impossible to carry it out owing to the want of sufficient staff for commissariat and sanitary duties; (2) the disinfection which is necessary cannot be carried out properly with people in the house, whilst it is always advantageous to allow an infected house to remain vacant for a few days during which time it may be freely exposed to the sun and air; (3) with a person remaining in the house, when the house cannot be disinfected, there will always be a considerable chance of the rats and other vermin becoming infected and spreading the disease in the neighbouring district; (4) the dangers to the people in attendance are always very great, but by removal of the patient to hospital these dangers are reduced to a minimum; (5) if exceptions are made in any case the murmurings of dissent are great, invidious distinctions are raised, and in the long run these may, and usually do, cause greater trouble than if the strict rule of isolation had been rigidly carried out. When the people amongst whom plague is likely to spread are being dealt with, isolation, to be efficient, must therefore be in hospitals. One thing should be guarded against from the very outset, a multiplicity of hospitals, as this leads to difficulties in the way of supervision and increases the possibility of the spread of disease. Hospitals must be situated as near as possible to affected areas in order that the difficulties of transport may be reduced to a minimum, and especially that the sick may be as little exhausted as possible by removal. The popular outcry which takes place when a long journey is necessary is certainly justified when a large proportion of patients die during removal to hospital under such conditions. Proximity of the hospital to an infected area means also that a smaller staff and a smaller transport train are required for the removal of patients—a most important matter in a severe outbreak.

With regard to the situation of a plague hospital, any airy place on open ground should be chosen if it is available, but where satisfactory restraint can be carried out in a building or open space, enclosed by iron railings or brick walls, in proximity to the affected area, such may be used as an hospital.

In selecting the site the question of the possibility of rats and vermin carrying infection from the hospital must always be borne in mind, and where there is any risk of this method of infection coming into play the most careful measures should be taken to prevent it by the free use of chloride of lime on floors and about the house, &c.

Floating hospitals in a seaport town or in a town on a river should only be used as a *dernier ressort* owing to (1) the expense of procuring suitable boats and accommodation; (2) the great trouble experienced in removing patients from their homes to the hospital and corpses from the hospital to the burying ground. The confusion around such hospitals in epidemic times is considerable.

When there is plenty of space at the disposal of the authorities, the hospital should be composed of rows of huts in *échelon*; these huts should be erected to contain only one row of beds. The reason for this is that terrorising scenes are often witnessed in plague hospitals, and such scenes should be witnessed by as few patients and friends as possible. This difficulty is best met by having only one row of beds. Every cause of fear or panic among semi-conscious patients and their friends should, if possible, be removed, or they lead to trouble and give rise to much unnecessary annoyance and difficulty in carrying out effective plague measures. Experience leads me to suggest that the above arrangement of beds goes far to prevent the occurrence of panic troubles. In practice, screens are not satisfactory in a general plague hospital, and considerably restrict the free supply of fresh air which is so necessary alike for patients and attendants. It is, of course, impossible in large hospitals to class plague patients as conscious, semi-conscious, wildly delirious, &c., and to keep them in different wards or parts of wards.

There must, however, in every hospital be a separate observation ward, in which cases of fever and doubtful cases may be detained until the disease is diagnosed. It is evident, too, that one of the first things to be attended to is to make the hospital as attractive as possible to the people; for this reason it is necessary that nurses and doctors should be supplied in satisfactory numbers, that the commissariat arrangements should be carefully looked after, and that the furniture and general arrangements should be as comfortable and complete as possible. It is sometimes argued that the fittings for emergency hospitals need not be first class, but as disinfection of such fittings can at any time, and as often as necessary, be easily carried out, there is no reason why they should not be substantial, especially when one considers the interests at stake. Opportunities should be given for different castes or combinations of castes to supply their own hospitals; these, however, must be completely under the sanitary control of the authorities. Temporary plague hospitals pitched on turf or sand with a cement floor are always preferable to substantial buildings.

House isolation as an alternative to hospital isolation cannot be carried out under any conditions. It is so hopelessly unworkable that it is difficult to imagine what would follow its adoption. Several methods, however, have been proposed: (1) complete house isolation, where the sick would be isolated either in one room or on the roof, whilst the other members of the family are kept in the remainder of the house; (2) isolation of the sick in their own houses and removal of the rest of the family to empty houses in a healthy neighbourhood without control;—if not to healthy houses, then to a camp.

With regard to these proposals it is to be assumed that, if attempted, the attempt should be as thorough as possible. In such a case what would have to be carried out? It would be necessary to procure (1) some sanitary attendant in the house who would continuously look after disinfection—sanitary police; (2) a guard for the house; (3) commissariat supply, which includes all the necessities of life.

It is difficult to see how in complete house isolation in an Indian town arrangements for scavenging, removal of night soil, urine, &c., all infected, could be carried out when it is remembered that the habits of the people are filthy in the extreme. All this filth must be removed from the house, and in carrying out this removal it is more than possible that the guards and other people in the house would become infected. Then, again, when the patient dies in such a house other difficulties arise. He must be buried by his friends or by the authorities, and, if the friends do this, the isolation of the sick and

suspects at once becomes a dead letter. If, on the other hand, the authorities are to carry out the burial, in addition to looking after the carrying out of the other measures, a further large staff to cope with these burials would be necessary. Moreover, removal by this staff would in India be greatly resented, and further difficulties would be added to those already sufficiently numerous. If the sick are isolated in houses, and the friends who have been in close contact are allowed to bury them when dead, it is extremely probable that some of them will be infected, and these will now in turn propagate the disease. If the sick man is removed to hospital at an early stage of the disease and his friends are placed in favourable conditions, they have very much less chance of being infected by the house or its contents. They may even be allowed out of the hospital or segregation camp to bury their dead, as, if they do manage to escape afterwards, their chances of spreading the disease have been diminished from a hundred to one.

House isolation kept on under insanitary conditions is almost certain to end in nearly all the inmates contracting the disease and dying, and panic and difficulties increase. The isolation of the sick in their own houses and the removal of the rest of the family to empty houses in a healthy neighbourhood is also impracticable. It is questionable if empty houses could be procured, certainly they can seldom be found in any considerable or sufficient numbers. The housing of the same people in observation camps comes to just the same thing as the segregation of suspects, which has been advocated, and to which there has been such strong objection. The sick cannot be left in the house, as in spite of disinfection it may, so long as a plague patient remains there, again become infected, the patient of course remaining as great a source of danger as ever. If the attendants on the sick man are to supply food, the chance of their spreading infection is also to be reckoned with. Again, the duties of scavenging the house must devolve upon other attendants, whose isolation must necessarily be impossible, so that the number of infective centres becomes enormously multiplied. Nor does merely removing the suspected diminish the difficulty regarding commissariat and sanitary arrangements already indicated, whilst rats and vermin still have every opportunity of becoming infected or carrying infection, and the necessity of supplying a large number of guards under these conditions of course greatly increases the expenditure.

Many other minor difficulties will at once strike any one who commences to calculate how this house isolation is to be carried out. In the first place it must be with the aid of European or Native troops; civilians would be of no use in such work, and the ordinary sanitary staff of a town could not well be employed on such work. The Government could not supply a medical and sanitary staff large enough to look after the constant disinfection requisite in any large number of houses—if one hundred houses only were infected, it would be difficult to provide the staff to carry out the operations. The expense of carrying out these measures as proposed would be enormous and the result utter failure, as it would be impossible even under the most favourable conditions to prevent the escape of some of the inmates, any of whom might infect fresh localities. Some extra segregation or isolation accommodation is always necessary in any case, and after house isolation has failed it is somewhat late to arrange for this accommodation, as labour becomes dear and scarce whenever an epidemic is well established.

Medical Observation of People who are suspected of having Plague.

As with those affected with other infectious diseases, those who there is reason to believe may be suffering from plague must be kept under proper medical observation. The method of carrying this out must vary in different countries according to the customs of the inhabitants, the supply of medical men, and the class of the population whom it is necessary to keep under observation. Amongst Orientals of the class who are specially affected by plague, this can only be carried out by placing them in a segregation camp for observation during a time which will cover the ordinary incubation period of the disease. The necessity of such removal from the house to the segregation camp is two-fold: (1) observation is impossible if those who have been exposed to infection remain in the houses, owing to (a) the dearth

both of medical men and of guards, (b) the fact that the people would probably flee, and (2) it allows a thorough disinfection of the house and its contents, as also the clothing of the people, to be carried out. This process generally takes some time in most of the houses of the class that usually have to be treated, and as has been already mentioned, it is desirable to leave the house open to the sun and air for a short time after artificial disinfection has been carried out. In practice it is found that one member of the family may be safely left in charge to look after furniture, &c., during disinfection and cleansing operations. A few examples will show how extremely necessary this segregation of suspected cases is, and here it is really a case of *ex uno disce omnes*. It is a most common experience to find that at the beginning of an epidemic a man dies from plague, the case being unrecognized by the authorities; for the next ten days people who have been in contact with him also perish of the disease, after in their turn infecting others with whom they have come in contact. All the possibly infected should be kept under careful observation. By the possibly infected is meant all who live in the same house as the first patient, if they can be got hold of, and certainly all living in the same room—those who there are reasonable grounds to suspect may develop plague should be subjected to this process of observation. In Hong Kong in 1894 the last case occurred in October, since which time Hong Kong has been surrounded by a plague belt, and several cases were imported in 1895. From one house the body of a patient who had probably died of plague (this was discovered by the after history) was taken to the mortuary. The man had come from an infected port—Swatow. Seven days later two cases were discovered, one in the house where the deceased had been living, the other in the next house. These houses formed a regular rabbit warren where the inhabitants freely intermingled. All the inhabitants (about 30 in number) were removed at once and put under observation. The same evening two more developed plague, whilst of those remaining, five became affected on different days within the period of observation. Now, if these people had been allowed to go free, they would probably have set up further cases of the disease, which might thus again have become epidemic in character. They could not be kept under observation in their houses, as these had to be disinfected, cleansed and aired, in this case a matter of days. Until attempts to segregate in houses are made, it is usually not found out that such a thing becomes practically impossible on the second day or so; the most complete measures are rendered ineffectual and ineffective because the people, or some of them, somehow or other manage to escape. In Hong Kong in 1895 these observation and segregation measures were strictly carried out in connection with all the cases that occurred in the town, with the result that, although literally surrounded by plague, only 44 cases in all occurred in the colony.

Another example of the advantages of segregation of the probably infected occurred at Ahmedabad. Two cases of plague occurred in a square; it was introduced by travellers from Bombay. The sick had been visited by many people of the square, and the authorities deemed it necessary to segregate almost a hundred persons; this was done promptly, with the result that within the observation period seven or eight more were seized, most of the cases proving fatal. These cases were traced to various houses in the square, and had the segregation of possibly infected people been carried out in a less thorough manner a severe epidemic might have ensued. Such examples could be multiplied almost indefinitely. The multiplicity of plague marks seen on various houses shortly after the beginning of an epidemic of plague is the best proof of the necessity for getting all the people in an infected house removed as soon as possible and having them placed in a segregation camp for observation. The value of segregation for suspects must naturally vary at different periods of an epidemic; it is often impossible to segregate people for more than the time required to disinfect their houses. But a far more important reason for its not being so necessary is the fact that when the epidemic has reached this stage, the house-to-house visitation by search parties should be conducted so effectively that cases of plague are discovered within a few hours of the attack, and before they have had time to give off infection. Thus at the height of an epidemic, when the general measures are in good working order, segregation is not of such extraordinary

importance, but when the cases again become few and more difficult to find and are found to be suffering in the later stages of the disease, and more especially when plague bodies are only discovered at the burying ground, segregation again becomes a necessity if the disease is to be finally stamped out or prevented from again assuming epidemic proportions. The question may be asked, is it possible to succeed in stamping out an epidemic without compulsory segregation? The reply can only be that this depends (1) on the amount of voluntary segregation which always occurs when mothers and relations accompany the sufferer to hospital (these people, of course, are usually those who have been in closest contact with the patient), and (2) on the early discovery of cases—often a matter of very great difficulty.

It is almost unnecessary to remark that all the commissariat arrangements for a segregation camp should be most thoroughly planned and carried out before actual operations are commenced, and that not only should a few shops be opened in the camp, but arrangements should be made by the authorities for supplying the large number of poor, who must necessarily be segregated, with proper sustenance. The water-supply is a matter frequently fraught with difficulty, whilst the sanitary care of the camp and disposal of night soil always give trouble; if, however, plenty of wood for burning purposes is at hand, a rough and ready incinerator can easily be prepared. It should be understood that removal to a segregation camp is for observation and to allow disinfection of the house, and not primarily for removal on account of infection of a district or a many-familied house. It has been noted that the percentage of cases in Bombay and Poona after removal to segregation camp has been carried out has been extremely small, but this is not due so much to the mere removal as to the fact that the sick were discovered early and removed to hospital. Were the sick discovered whenever the temperature first began to rise, there would be very little necessity for removal to the segregation camp at all. It is generally arranged that these segregation camps shall be placed alongside or in close proximity to the hospitals; sometimes, however, accommodation for this purpose is so very limited that it is impossible to obtain a site for a separate hospital apart from the segregation camp. In such a case it has been found practicable so to arrange the hospital that a whole family can be taken in and sufficient precautions taken to prevent those not already infected from becoming infected. In many of the districts, where only a few cases of plague occur, it is of course possible to do without a segregation camp altogether.

Discovery of Cases.

An essential factor in the successful treatment of a plague epidemic is the early discovery of all cases; the difficulties in the way of this however in large towns and cities are very great. It is nevertheless one of so great importance that, unless it be carried out properly, isolation of the sick, &c., need not be attempted—they will probably prove valueless.

This early discovery can only be effected by efficient house-to-house search in the infected districts by regular search parties. The duties of the parties to whom this work is entrusted must be as follows:—their orders must be carried out thoroughly and with both vigour and discretion, as, if carried out without due regard to the necessities of the situation, the outbreak will drag on much longer than it ought to be allowed to do. All sick of the plague should be removed at the earliest possible moment after being attacked. All cases of fever suddenly developed must be removed to an observation hospital or ward; they should never be allowed to remain in a house when there is an epidemic of plague. By early removal of these cases much harm is prevented; most of them turn out to be plague, whilst, in practice, it is often found if those that ultimately turn out to be affected with plague are left till the following day before it is definitely decided to remove them, the family run away and the patient is taken with them to infect fresh localities and people. Removal to hospital also gives the patient the best chance of recovery, and, if it is the first case in a house, the remainder of the family usually escape. If not the first case, it is often found that other members of the household are incubating the disease.

These search parties must also have control of the arrangements for the removal of all suspected people in an infected house; this usually necessitates

the employment of the police. The removal of suspects must always be attended with difficulty, as the care of the house which is to be evacuated has to be entrusted to some one during and after disinfection. It is therefore much more satisfactory to proceed with the disinfection at once and allow one of the inmates to remain as caretaker. When the vacated premises are left in charge of the authorities difficulties as to the removal or destination of contents frequently arise, so that for all practical purposes it is by far the best way to allow one of the family to look after the premises.

The material necessary for accompanying search parties is a supply of suitable ambulances. These must vary in character with locality and the demands of the situation. In educated towns the importance of a good supply of such ambulances is great; and the supply must be equal to the demand, otherwise all cases cannot be removed, and removal may be dangerously prolonged and until an inconvenient time.

It goes without saying that search parties must vary greatly in *personnel*. Medical men and women, when available, should always do the searching; they should be assisted by a police force whose duty it should be to prevent the escape of people whom it is necessary to examine. However, it often happens that a supply of medical men and women cannot be commanded; it is then necessary to obtain the assistance of educated Europeans in carrying out the search. Europeans without any medical training at all soon learn the use of the thermometer, and a few days' experience of plague enables them to diagnose plague just as easily as medical men and women. If educated people are not available, then European soldiers and police are generally the next best class to draw upon, and when non-commissioned officers of the British army can be called upon to assist, it is not long before they thoroughly understand the duties assigned to them. In this case the available medical force must be distributed as found necessary for successful work. It must be borne in mind that a large medical force for search work means a very large expenditure of money when operations have to be undertaken on an extensive scale, and when a successful search can be undertaken by non-commissioned officers or soldiers and police, without necessarily causing any further inconvenience to the populace than is occasioned by the performance of the same duties by a medical man or woman, these agencies should be preferred.

The educated European search parties can sometimes be drawn from clerks, solicitors, &c., and from the official classes who can be spared for such work; as a rule these make the best search parties. There are very few places in the East where a full search party of medical men and women could be procured, and then the drain on the finances is usually of a heavy character.

Female help is imperative where women are concerned, and where, for example, a number of nurses is at hand, such nurses should generally be used in the search parties in preference to hospital work, where the attendance of some of the members of the patient's family can usually be depended on to look after the patient until further help be procured. It is necessary from a humanitarian point of view to have nurses in the hospital, but natives often do not relish their attentions, and when search work is of such infinitely greater importance there should be no hesitation in utilising this part of the *personnel* for town work.

When search work is well done, its effect on the duration of an epidemic is very great. The removal of all cases of fever which have been attacked suddenly and the treatment of the house at once as "plague infected" are two of the most important factors to be borne in mind in connection with plague work. The possibilities of further spread of the disease are thus greatly limited, and the early removal lessens the chances of impregnation of the house with infection. It also encourages the notification of cases early when non-notification of cases is penal and penalties are enforced; whenever search-work is commenced in a thorough manner, the people of their own accord remove the sick to hospital. This is not altogether an unmixed blessing, as sometimes the house from which the patient has come cannot be found for disinfection; still this is only one of the difficulties to be met with, and where cunning must be met by cunning. A dependable detective police force is usually a great aid in such an emergency. The tendency on the part of the natives to remove, at once, bedding and clothes which are evidently of little value and are probably infected should be prevented by their

early destruction by burning or disinfection by the search parties. These parties are also of great use in bringing sanitary defects to the notice of the authorities, which would in the usual course of events go unnoticed.

Difficulties caused by peculiarities of configuration of streets and houses can only be met by having the assistance of police or military in the streets. These difficulties are usually met with only at the commencement of operations, as, if the search is being carried on satisfactorily and without creating disturbance, the people in the infected areas soon lose their fear, which at the beginning is usually considerable—generally from their ignorance of what is really going to happen. The discovery of infected villages and districts is only an enlargement of this measure. Here again constant efforts must be made to find out every infected district.

Registration of Cause of Death, Corpse Inspection, Death Statistics.

These three measures are so closely allied that they cannot be considered separately. In fact, corpse inspection and death statistics are practically the two parts of registration of cause of death. If to these is added notification of infectious disease we have the basis of and material for an "Information Bureau," a bureau absolutely necessary if we are to deal successfully with infectious diseases.

Registration of cause of death may be dismissed as far as India is concerned by saying that it will take a long time for the authorities to get any reliable returns, at least outside the larger towns and cities, although if a system of registration amongst the better educated medical men was at once commenced, valuable information might be secured when and where least expected.

At a time of threatened epidemic, corpse inspection is the measure from which the most valuable information can be derived, and in the case of no epidemic disease can this be more valuable than in the case of plague. I am now discussing it apart from all caste difficulties and merely to point out its importance.

When practicable it may be carried out at three important periods :—

- (a) When an epidemic is threatening a town or district.
- (b) During an epidemic.
- (c) After an epidemic.

Corpse inspection before an epidemic will generally enable the authorities to find the earliest cases of the disease, should the town or district become infected; if these cases could be discovered even after death, and measures of disinfection and segregation of the probably infected carried out, an epidemic could always be stopped.

The necessity for keeping up large search parties in some threatened towns is greatly lessened if a thorough corpse inspection can be kept up from the earliest period of danger. In many countries, and especially in India where the notification of infectious disease which is so necessary to prevent spread of epidemic diseases cannot be obtained, this inspection would enable the authorities to almost dispense with notification of infectious disease, so far as plague is concerned, as it is found in practice that if the first cases be detected through corpse inspection, the house disinfected, and the inmates segregated for observation, further spread of the disease does not take place. In a town where there is a high death-rate occurring and where there is any danger of an outbreak of plague occurring, corpse inspection should be at once carried out.

Corpse inspection during an epidemic adds greatly to the efficiency of the results of house-to-house visitation, from the fact that corpses which have escaped the vigilance of the search parties may often be detected. It may seem almost useless reiteration, but I would again insist that *the greatest element of success in dealing with a plague epidemic consists in securing and keeping under observation every human being suffering from plague at and from the earliest possible moment.*

As house-to-house visitation for the detection of the sick of the plague must cease at some time after an epidemic, and as a good complete registration of cause of death cannot be secured in India at the present moment, this corpse inspection must take their place and stand as an equivalent for

notification of infectious disease and registration of cause of death. Its efficiency in suppressing plague at this time is far greater than house-to-house visitation, as even with the most efficient search parties many cases are not detected, whereas with a good system of police and examination of bodies very few cases can be missed; indeed, to err on the safe side, cases which are considered to be doubtful and for which no good cause of death can be assigned should be treated as plague cases.

In cases of objection to this examination, the corpse should always be treated as plague infected and measures for plague cases carried out accordingly. In India the habits of the people in always remaining beside their dead till the burial rites are carried out afford the greatest facilities for carrying out the necessary measures; the people can be detained, and, if the police do their duty, can give all information usually required. In Hong Kong, on the other hand, it was nothing uncommon to pick up a score of bodies per diem—bodies which had been thrown into the streets by the relatives who desired to escape the cleansing and disinfecting of the houses. Under such circumstances it is, of course, an extremely difficult matter to secure infected units.

Some words are necessary regarding the examination of corpses and its results. I grant that all cases cannot be detected by this means, hence some people object to it because it cannot lead to the discovery of *every* case. The same objection is made to a *Cordon Sanitaire* for detention purposes—because everyone cannot be stopped,—but the Chancellor of the Exchequer does not cease to collect as much Income Tax as possible because every sixpence is not collected. The efficiency of this inspection will depend, firstly, on the men who are carrying out the examination. Where these men have had a large experience amongst plague corpses—not necessarily from post-mortem examination but merely from looking at them—a very large percentage of cases will be detected, even although no bubonic symptoms are present.

At the commencement of the 1894 epidemic in Hong Kong over 90 per cent. of the bodies *at least* had buboes which there was no mistaking. Towards the end of the epidemic between 75 per cent. and 80 per cent. were in the same condition, and, if the patients were alive and without buboes, the sudden fever, with delirium and foul “plague tongue,” usually sufficed for a diagnosis of plague.

Even in 1896, where large buboes were few in comparison, 73 per cent. had glandular swellings which betokened plague, and which were proved to be due to this disease on partial post-mortem examination. This experience in Hong Kong must be placed before any Indian experience, as in the former place in 1896 the opportunities for examination and post-mortem confirmation were very good indeed.

Indian hospital results show variation from 50 per cent. to 90 per cent. of admitted patients having glandular enlargement, and this even including cases of mistaken diagnosis. Even in cases in which on admission there is no glandular enlargement, a bubo frequently occurs at a later stage of the disease, and in these cases often just before death, a fact which, from the nature of the hospital work, is sometimes not noted in the records.

The only way to arrive at any accurate estimate on this subject from Indian experience will be to compile tables from all the reports of post-mortem examinations made there. Although the pneumonic type prevailed largely in India, it should not be overlooked that a very large percentage of these had also bubonic symptoms. In 1895 in Hong Kong 95 per cent. of cases had buboes. In Mesopotamia, Dr. Cabiadis gives 74 per cent. of 1,826 cases as having buboes. Dr. Bitter, out of 100 odd cases in Bombay, gives 89·6 per cent. of cases as having buboes.

The efficiency of corpse inspection must also depend largely on administrative arrangements. It can be carried out by several methods. The district or town may lend itself to carrying this out in special mortuaries, the corpse being certified there and a certificate taken with it to the place of burial. In other cases it may be carried out at the disposal grounds—burning ghat, burial ground, &c. In other towns again, a system may be organised for the examination of all bodies before removal from the house, as was done in Poona on a complete scale, and where this can be carried out, it is usually the most efficient system—the inhabitants are much more easily

treated and there is less difficulty in carrying out the further necessary measures. In time it is anticipated and desired that a good system of registration of the cause of death may supplant all these emergency methods.

In considering this system of inspection, post-mortem examination has been left out of account altogether, as it must at once be recognised that such examination on any large scale is an impossibility, though in Hong Kong it was found possible in the later weeks of the 1894 epidemic and in 1895 and 1896 to procure a partial examination for bacteriological material in all doubtful cases.

Other signs of plague which may assist in making a correct diagnosis are:—

- (1.) The sordes on lips and tongue—generally present.
- (2.) The occurrences or remains of hæmorrhage from mouth, nose, or anus.
- (3.) Unconscious urination or defæcation—often found.
- (4.) A rise or continuance of temperature above the normal.
- (5.) Hypostasis usually well marked.
- (6.) Surroundings, such as the presence of pneumonic sputa in the room, often give help.

It goes without saying that the notification of infectious disease will be of the greatest use in plague. In fact it is *the* disease where it is most required but, unfortunately, plague at the present time only has a chance of flourishing in countries where this measure will certainly never be carried out properly for many years to come. As has already been pointed out, information must be got by house-to-house visitation or corpse inspection. Even in Bombay with a large number of medical men, the notification of plague cases will depend so much upon money matters that it is doubtful, even if introduced, whether it would ever be of any value in case of plague, where measures have to be undertaken which are so intensely distasteful to the populace, and to escape which they would be willing to pay large sums of money.

Registration of cause of death, likewise, would be a difficult matter to carry out, if required for plague purposes alone, and then it would be necessary that these should be carried out almost entirely by Government medical registrars of a very competent and trustworthy type. When this is said, all that can be said in the matter is said, and it must be admitted that thorough plague operations can only be practically carried out by corpse inspection.

A certain amount of information can no doubt be derived from procuring accurate statistics as to the number of deaths in a town and in the different districts or wards of a town, which will draw attention to increased death-rate in particular localities and where further investigation is at once necessary.

Evacuation of Districts of Towns or Villages and the employment of Health Camps.

As regards *districts of towns*, evacuation should only be resorted to when these are badly infected and especially where the epizootic amongst rats is considerable. If the measures described earlier in this report are carried out from the beginning of an epidemic, there will be no necessity for such evacuation, but as cases occur where, owing to an inadequate staff, the disease has become intensely epidemic, it is sometimes necessary to consider whether removal of all the inhabitants of part of the town is desirable or not. If a camp is formed to house these people, the cost of working it from a plague point of view is just as great, if not greater, than would be the cost of working the infected area, apart from the cost of disinfection and cleaning. If the district is evacuated because it cannot be properly worked, then it will be found that carrying out plague work in the camp is almost as difficult as working the town itself. This cost of working does not include the primary cost of erecting the camp. It is needless to say that if the district is a densely populated one, the space required for the camp will of necessity be very great, many times the size of the evacuated district, and in many large cities it will therefore be impossible to find the ground necessary for such a camp, more especially if a water supply be not at hand, and sanitary matters have to be arranged. Those removed must be under complete supervision, as in this case

the probabilities of an outbreak amongst the people would be great, and an outbreak of plague in a health camp might be so severe and widespread that no good would be done by the removal, whilst in addition to carrying on the disinfection and cleaning up of the evacuated district, a large amount of disinfection and cleaning up would have to be done in the health camp. The disease will go on in these camps as before, unless the sick are detected and isolated early, observation of suspects and thorough disinfection carried out. This is exemplified by the case of Karachi, where health camps were formed without proper isolation of sick, segregation of suspects, or proper disinfection in the camp, such as should invariably be carried out where many people are gathered together.

Evacuation of villages is frequently necessary because where a large number of villages are infected at one time, and no staff is available, a judicious distribution of the inhabitants will lessen the risks of infection. Dispersion of families in a house or families in a village must lessen the chance of the hitherto uninfected families contracting the disease. The same will hold good of a town, if room and suitable arrangements can be made, but what is now being spoken of is more of a thorough dispersion than a health camp. It must be understood that this dispersion must be really secondary to the primary principles of work laid down. In small villages composed of huts there may be intense infection owing to the natural progress of the disease, and if a family camps out after one member is infected, the disease generally goes on in that family, even although the camp is changed every few days. Camping out only gives the hitherto healthy people a good chance of escaping by keeping them away from the disease. In Bulsar and Cutch Mandvi, not to mention many other plague spots in India, good examples of this were seen. Several families had moved their camp to different places every few days after the death of one or two of their number, and yet, as was to be expected, as no disinfection was carried out, these families were gradually swept away. One family at Kutiana in Kathiawar had moved into no fewer than seven separate clean and healthy houses before the last member was ultimately carried off. In a village of small dimensions the infected families should be kept together and under the closest observation. In such a case the village becomes the hospital and segregation camp in one.

In deciding whether to camp out or not, it is to be assumed that there is space for a camp; another important point to be taken into consideration is whether the available sanitary staff will be able to supervise the camp better than they could supervise the town or village, more especially if the camp is scattered. The expense is sometimes a serious item and this money would in most cases be much better spent in increasing the staff. A much larger staff is usually required for commissariat, guarding, and sanitation of a camp than of a town or village, though against this drawback must be noted the fact that the mere detection of the sick in a camp is easier than it is in a town, provided the huts are properly arranged and not too much scattered. It must be remembered, too, that the troubles of moving large bodies into and out of a camp are necessarily very great in a plague town. If suitable plague measures are commenced early in any town or village, camping out is certainly both unnecessary and undesirable.

Destruction of rats and animals.

The destruction of rats unfortunately is a difficult task. In Bombay, when operations commenced under the new *régime*, few rats could be found, in fact so few had they become that money could not buy them for experimental purposes. In Poona the rat epidemic had progressed considerably before work on a large scale began, and this was also the case, I understand, in Kurachee. At Baroda an attempt was made by using the popular poison "Rough on Rats" to get rid of these vermin, with what success I have not heard. At another place poisoned grain was used on a small scale, but some children, gaining access to it, ate it and were seized with symptoms of arsenic poisoning, in consequence of which and the poisoning of domestic animals further attempts to use it were abandoned. The objections of the sect of Jains to kill any animal whatever led to so much administrative difficulty in one or two localities that the campaign against these animals

had to be abandoned. On one occasion the mere mention of disinfectants as being used to kill the bacilli of plague, which I designated animals for the time being, brought about a cessation of work, and some explanation had to be made before it could be resumed.

The rats will never be exterminated without the assistance of the inhabitants. An attempt might be made in a city like Paris, with its large sewers, to bring about a wholesale poisoning, but their destruction in an Indian city is fraught with the utmost difficulty. The organisation of a small army of Native rat-catchers seems to me to be one way of meeting such difficulty at present, and this might be supplemented by the distribution of a leaflet in the various districts where the possibility of an outbreak of plague is contemplated, pointing out the dangers and explaining in a popular manner the reasons why all should unite to exterminate these vermin. If such extermination could be brought about, I am confident that a *great spread* of plague would be very improbable, provided that the other ordinary precautions were taken to stamp out the disease. It must be borne in mind, however, that the danger from rat infection can be greatly reduced by the proper use of disinfectants, chloride of lime in particular, and this article should be freely distributed for the use of the inhabitants of an infected district where evacuation cannot be carried out. Here again the Natives frequently refuse to use this substance, and it is only by judicious persuasion on the part of those carrying out the administrative work that they can be got to see the necessity for its use and be brought to act upon their acquired knowledge.

To overcome the difficulty of domestic animals being poisoned by the grain left in the streets, I would in future make an effort to poison the rats by spreading the grain out on wooden trays in favourable spots of the town or village, and then on the third or fourth night add the arsenic to the grain. The trays could be removed every morning and replaced at night, and in this way the chance of unnecessary poisoning of domestic animals would be minimised. Such a campaign against the rats should always be attempted immediately the rains fall, as the number of these animals which then migrate from the fields to the villages is very large, and an introduction of plague at such a period might be followed by a very rapid spread. Slaughter by the introduction of some bacillary poison is outside the range of practical work at the present time, and our chief weapons of offence must be poison, dogs, and the individual efforts of the inhabitants.

Where monkeys abound in large numbers—such as at Ahmedabad and numerous places in the northern parts of the Presidency—the danger of spread by these animals will have to be borne in mind. Their numbers can fortunately be more easily reduced than those of the mural race.

Restriction of Movements of People.

From what has been already written, it is evident that one of the main weapons to be used in fighting plague is the restriction of the movements of people in and from affected districts, in order that possible centres of infection may not be established beyond the plague area. It is for this reason that I insist so strongly upon the limitation of such movements. At the same time I look upon quarantine simply as a means of keeping suspects under observation, and also of obtaining a thorough disinfection of all their belongings; whilst, on the other hand, I look upon disinfection of the clothing of people from infected areas, and the time that may be taken in this process, as affording an admirable opportunity of keeping suspects carefully segregated and under medical observation, so that, should symptoms of plague be developed in any of them, it shall be while they are being watched and not after they have got beyond the reach of efficient control. The difficulty in applying English methods to India is to know where medical observation in homes is to end and medical detention for observation is to begin. In India medical observation in the patients' own homes soon becomes an impossibility, and medical detention becomes an absolute necessity if there is to be any hope of success in dealing with an outbreak. I am persuaded moreover, from personal observation of their habits and customs, caste, &c., that there are no insuperable difficulties in dealing with natives which cannot be overcome by the exercise

of tact and energy in the prompt application of detention in forms which will be objectionable to the natives only on the general grounds that they would be objectionable to Europeans.

It has been maintained that it is impossible to carry out efficient measures such as those I have mentioned, but I am convinced that the difficulties exist only in the minds of those who are not willing to look the position fully in the face and to grapple with it energetically, but with discretion. Whether extreme measures such as a *cordon sanitaire* with a system of sanitary passes is to be adopted, or whether travelling is to be discouraged by stopping of booking by trains with a simultaneous notification to surrounding villages to adopt quarantine, or the simplest forms of supervision and restriction are to be carried out, will depend greatly on the geographical position of the plague centre, and its relation to surrounding populous districts; upon the number and character of the men at the disposal of the responsible authority; the source and nature of the food and water supplies; the facilities, actual or potential, for local isolation; and above all, on the power of initiative of those in authority, and the tact, energy, and attention to detail of subordinate officials and assistants.

Concerning the question of the limitation of departures by rail from an infected city, I look upon it as being fully as necessary as the departure of pilgrims by steamer, and I don't see why the same consideration should not be shown to the various parts of India itself that is accorded to countries outside, when the question of the loss of thousands of valuable lives is weighed in the balance against some slight inconvenience and temporary derangement of traffic and business, with of course some falling off, but a comparatively small one, in the dividends of the railway companies.

Where well-known people are travelling, either Europeans or Natives, who can be trusted to remain in touch with those in authority or where sanitary passes have been granted, there is of course no object in restricting movement, but for the general passenger traffic such as that with which the companies have always to cope, especially at the commencement of an outbreak in a large city or even in smaller towns, certain restrictions must undoubtedly be put in force, and the sooner this is recognised, the more rapidly will plague be again brought under control.

With regard to the spread of disease by the pedestrian traffic, it may be stated generally that what applies in the case of railroads also applies here. Here, of course, in carrying out any system of restriction of foot traffic the use of cavalry patrols, infantry or police pickets, is necessary—especially on the roads in the immediate neighbourhood of a plague centre, bearing in mind always that the further from the plague centre these patrols and pickets are placed, the less effective they become. In fact, this principle of working as near the centre as possible, applies to every measure to be adopted in plague work, with the single exception of those relating to railway inspection where the train in most cases must be looked upon as a segregation camp, and is therefore a centre in itself, whatever distance it may be from the point from which it started. Although it is necessary where possible to put one's finger on the fugitive population as near the plague centre as possible, it is also necessary that small communities should be protected against arrivals of plague-stricken patients, who have eluded central observation, and with this object in view, local districts and even small villages should be encouraged to protect themselves by putting into force any or all possible rational measures of quarantine. They will do this the more readily as they are led to recognise the gravity of the situation and the danger in which they are placed, especially when the trouble and expense resulting from a neglect of these precautions are pointed out to them.

In the case of sea traffic the same principles again apply. Fishing boats should be detained where possible and kept under observation at the central port for a period of at least ten days. The opportunity should also be taken in this case to disinfect, during the quarantine period, all clothing. With regard to large steamers departing to ports where quarantine examination is enforced, the examination of passengers, especially Europeans, is of comparatively slight importance. Here, however, I would insist most strongly upon the thorough disinfection of all members of the crew, along with every article of their clothing, before any ship is allowed to leave port.

Not only this, but I would insist on a thorough cleaning and disinfection by lime, &c., of the quarters occupied by the crew every time the vessel comes into the harbour of an infected port. This should be looked upon as an essential routine procedure before a ship is granted papers of clearance. In regard to this matter, I consider that the Venice Conference has passed over one of the most vital of all the questions with which we have to deal in protecting European ports against an invasion of the disease, and that this is not merely an objection on theoretical grounds is borne out by the fact that several cases of plague have arrived at various times in certain of our home ports. Such disinfection as that above mentioned is practically a very easy matter readily carried out, and will, if properly done, effectually prevent infection by clothing during the voyage. This clothing is frequently not used till colder regions are reached and the danger only commences when such clothing is brought out for use. It is for this reason that the disease in these cases does not break out during the first ten days of the voyage, and sometimes not until a vessel may have arrived in a home port. If the measures recommended by the Venice Conference be thoroughly carried out with the addition of what I have mentioned above, I have little doubt that plague would never find its way from India to Europe direct, *per mare*.

One of the most difficult aspects of the sea-quarantine question in the East is the provision of sufficient accommodation which, to be effective, requires the expenditure of considerable sums of money, sums which at present can only be obtained from general revenue, a source which most legislatures naturally regard as closed when demands on a large scale for the carrying out of such objects are made. I do not see, however, why the bulk of the expense of quarantine should not come out of shipping fees and revenue. At present, ships pay dues for the privilege of coming into port and the quarantine due should simply be looked upon as an additional port due, just as are lighthouse dues in many places.

To strive for an ideal system of medical inspection, observation, &c., as carried out in England, is no doubt laudable, but it may as well be recognised at once that at the present moment in dealing with Oriental races such an ideal method of procedure is out of the question, and we must not make the mistake of rearing an elaborate system which will, with even a single weak link, break down most disastrously under the first strain put upon it, when by the adoption of simpler and more direct methods safety can almost certainly be guaranteed. With the present lack of any reliable system of death-registration and notification of infectious diseases the remainder of the ordinary English system is absolutely useless in countries where the medical detective system is so hopelessly unworkable by reason of want of medical men and the peculiar characteristics of Oriental races. That there is this lack my own experience and observation and that of others have thoroughly convinced me. Medical observation of the healthy in Oriental countries is easy enough, as healthy people do not object to being examined, but when such people become ill all trace of them is usually obliterated, notwithstanding the efforts of a most efficient detective sanitary force. Cases may occur where countries or ports have to run the risk of constant introduction of plague; in such it is folly to carry out medical inspection where observation during the incubation period cannot be carried out by reason of the habits of the people. The healthy will often turn up for examination, but the sick will be off in hiding at once in order to save all the inconveniences arising from the presence of plague becoming known to the authorities. Such a condition can only be remedied by the formation or increase of a sanitary detective staff who should be constantly on the watch for cases occurring in the locality.

I am firmly convinced, however, that a middle and safe course between the early rigid quarantine system and our present English system can be carried out; one essential feature in such a modified system being the ten days detention period for observation, or where for any reason this is not practicable, a contingency not likely to happen, a strict *cordon sanitaire* appears to be the only alternative if a successful result is to be obtained. These may seem extreme views, and difficult to carry out, but with the resources of men and money at the command of the Indian Empire, there should, I feel sure, be no difficulty in putting them into practice thoroughly

and effectively, in which case, I believe, they would be followed by the most beneficent results. During the last three months the plague situation in India has again changed enormously, and we cannot close our eyes to the fact that every day further changes are being made, and new difficulties arising. The number of infected centres is being rapidly multiplied, and the possibility of stamping out the disease from so many areas is daily diminishing, for now that the facilities for travel have increased so enormously, the conditions for spreading the plague into areas into which fresh pabulum is always ready to hand have become much more favourable, and India to-day, on account of its railway facilities, stands in a much worse position in regard to the possibility of stamping out the plague than it did in 1815—1821 and 1836, even with the want of knowledge of the nature of the disease, and of the action of disinfectants that obtained at these times.

The object of the above remarks is to indicate that it is desirable in some way or other to bring back India to certain conditions that prevailed in earlier epidemics where the spread of the disease was comparatively limited. Unless this is done it appears probable that plague may not be driven from the country for years to come, in spite of the expensive measures that are now being taken for its local eradication.

It appears to me then that the time has arrived when large observation camps should be formed at various strategical points throughout India, where railway travellers not possessed of a sanitary pass can be detained for the limit period of incubation, as also for disinfection. These camps should be numerous and should be situated principally on the various railway lines. During the earlier part of the year when plague cases were diminishing rapidly, and the extension to new districts was comparatively slight, such an advanced step did not seem to be necessary, although in various localities they proved of the greatest use; but now that so many infected areas are noted in the returns, it seems to me that the adoption of this measure, extreme though it is, should be immediate. A slow march of the disease from village to village by road travellers is also to be feared. One hears much about the walking capabilities of the native of India, but this of course relates to his performances when in a perfect state of health. It is improbable that many persons incubating plague would make a very long journey before becoming so ill that they would have to discontinue their journey. The stoppage of such travellers by sentries on the roads would not cause nearly so much opposition as wholesale stoppage of railway traffic. Observation camps could be placed so as to intercept most if not all, of those fleeing from infected areas. There must necessarily be some interference with the liberty of the subject even though the dividends of the Railway Companies should suffer. So far, racial and religious differences have been the salvation of areas situated at considerable distances from the seats of disease, but if the slow march by road is not also dealt with, it is more than likely that this slow march will end in the infection of these distant areas where infection could never be carried through railway communication.

Caste Fairs.—The stoppage of caste fairs must be governed by several considerations. In connection with plague, this is a very different matter from such stoppage in connection with cholera. If a large number of people from an infected district go to a fair, a considerable risk that plague may be introduced must be run, but, if the fair only lasts for five or seven days, the risk of infection of people who have arrived from healthy districts should be infinitesimal, if the authorities are able to preserve a careful watch over them and to control their movements. At these fairs the most important measure to be undertaken is a most careful inspection of every dead body disposed of during the period of festival. A widespread infection by plague at such fairs could not possibly happen without the knowledge of the authorities, whereas in the case of cholera, such widespread infection might readily be set up. The stoppage of fairs and festivals would *a priori* seem to be the most difficult plague measure to put into operation, as it is a greater interference with caste, or at least touches the question of caste more closely, than, for example, segregation of suspects, or inspection of corpses. The danger arising out of these fairs, however, would seem to be run almost solely by the

town or towns in which they are held. The proof of this was given at Hardwar. The question of stoppage of festivals therefore depends on (1) how much interference there will be with caste prejudice, and (2) can the local staff supervise the arrangements necessary for detecting and treating any outbreak of the disease?

The risk of widespread infection need scarcely be taken into consideration; if it occurred it would probably be secondary to a considerable infection of the place where the festival was held. The prohibition of people going to or from such from an infected area should be carried out under the ordinary rules of medical detention of people leaving such an infected area.

Medical Inspection.

Railway inspection is only a very slight preventive of spread of plague as it does not get over the question of incubation period. In long-distance travelling it should be remembered that, with a slow train, and the inspection point as near as possible to large centres, there is less chance of introduction of the disease, owing to the period of observation in the train being longer—the train is the observation camp.

Sea inspection of those departing from an infected area, when extreme restrictive measures are not carried out, is only essential for those leaving for ports where no inspection or quarantine can be carried out. In an Indian epidemic the inspection of Europeans leaving for ports where there is an inspection is waste of energy which could be directed to more valuable work, more especially considering how few Europeans get plague there; that *spread* on a ship is so rare that there is no well authenticated case on record; that the ship is an ideal segregation camp with a medical officer constantly at hand, &c. As a measure to satisfy European nations it may have been necessary, but it is not required now—it is a waste of material which could easily be put to better account. It is the duty of the ship's surgeon to see whether any cases go on board before leaving. Few, if any, Europeans have developed plague after being prevented from leaving India—more have developed plague after leaving. The energy displayed in examining ships leaving for ports where examination is carried out should be devoted to disinfecting the clothing of crews and all dirty linen taken on board. It has not been the thorough examination of departing European passengers for foreign ports which has kept the latter clean, it is the fact that Europeans in India who leave the country do not associate with those who are affected with the disease. The proof of this is the result—I understand no Europeans were detected at Bombay, several at ports of disembarkation or *en route*.

Serum-Therapy.

Serum-Therapy in plague is at present at an interesting stage from the scientific point of view, but as a practical method of treatment we as yet know little; certainly only a brief opinion as to its value can be given here. Laboratory prophylactic experiments with anti-plague serum have been so successful that its use as a preventive or protective measure may perhaps ultimately allow of some modification of the segregation at present so necessary in dealing with Asiatic suspects. Even with a weak anti-toxic serum good results have been obtained. As to its use as a curative agent in practical medicine, it has been a comparative failure both in Bombay and in China, in spite of statements which have been made to the contrary. This failure is scarcely to be wondered at when it is borne in mind that the serum employed was admittedly of weak anti-toxic power, and that the practical difficulty of bringing the patient early enough under treatment to give him a fair chance of recovery has been against the success which we are led to hope will one day attend its use in European patients, should any treatment be necessary. Results have been claimed for it in cases where diagnosis of plague could not possibly have been made with any degree of certainty, but a proper trial of a strong serum in an open scientific manner in a large number of non-selected and carefully diagnosed cases, which would be of the greatest service at present to mankind, has not yet been made for the reasons above mentioned.

As a prophylactic for those engaged on plague work—especially natives—its use should be of the greatest value, and I would suggest that its preparation should at once be carried out under proper Government control and *by men specially trained in this branch of work.*

In connection with the anti-toxine treatment of plague it must be remembered that any prophylactic effect produced by it will, if analogy holds good, probably be of a merely temporary character, *i.e.*, the immunity is merely “passive,” and persists only for so long a period as the plague anti-toxine remains in the body. Were this anti-toxine of sufficiently high potency however, this could be no great drawback to its use as a prophylactic agent, to be administered to pilgrims leaving India or to those who have been in contact or are likely to come in contact with plague patients or infective material for a short time only. Efficient anti-toxine might under certain conditions be the means of rendering strict segregation not quite so necessary, and in plague work serum might possibly, in time, come to take the place of the sepy.

Inoculation of Vaccine Material.

This was carried on by Haffkine in Bombay Presidency, but with what success it is difficult to say. Figures which have been given of what occurred in the House of Correction would tend to show that its use there was of benefit, but such figures are very incomplete and much more information is required, information which I understand cannot now be procured. This refers especially to the opportunities and possibilities of infection of prisoners. In my opinion this form of protection will never come up to that provided by an anti-toxic serum, and the reason of this is that the pain and discomfort of the present inoculation is so great that, unless the inoculation can be “sprung” on a whole community at once, the results of inoculating a few are generally sufficient to cause the remainder to fight shy of any such vaccination. Whether it can be prepared so as to cause less discomfort, or even to be given by the mouth, still remains to be seen. If this latter can be done, and especially if the dose can be condensed into small bulk, and it can be given under the guise of a popular remedy against plague, it is possible that some progress may be made in the direction of protecting Asiatic races. The laboratory work in connection with vaccine has so far not given very successful results, and the results on man at least have not proved so striking as one could wish.

It must be borne in mind that Haffkine’s vaccine method is both in principle and detail perfectly distinct from the serum treatment. Yersin produces changes in the tissues of the horse, in consequence of which anti-toxin is thrown out into the blood of this animal; this anti-toxin, which is still contained in the separated serum of the blood drawn off from the animal, is injected into the patient; so long as it remains in the system it does its work but as it is excreted no more takes its place and the protection is lost. Haffkine produces the same series of changes in the human subject that Yersin produces in the horse, as a result of which the patient manufactures his own anti-toxin, and continues to manufacture it for a considerable period even after the immediate necessity for its action has passed away. Not only is anti-toxin formed, but the tissues of the patient acquire a power of resistance to the action of the plague bacillus that they previously did not possess. In consequence of these tissue changes the immunity in this case is spoken of as being active, *i.e.*, it is the patient himself, and continues for a considerable period. The active process goes on in the patient instead of in the horse as in the other case.

In both cases the dead bodies of plague bacilli are first injected under the skin (in the one case of the horse, in the other of the patient) in order to produce slight insusceptibility to the disease, then bacilli weakened by heat or by chemicals, and only at the final stage are fully active bacilli injected in order to obtain the greatest possible protection. These bacilli and their poisons, in gradually increasing quantity and strength, set up reactions in the tissues by which these latter are able to carry on their work in the presence of the virus, with the result that the bacilli and poison are both gradually eliminated or neutralised without interfering very seriously with the health of the patient. The active immunity being of a more

prolonged character, may possibly be preferable for those who are to be constantly or for a long period engaged in plague operations. Owing to the nature of the process, it must always remain a prophylactic measure, and can never be applied in the treatment of cases of declared disease. There is still a large amount of theory in serum therapy and inoculation which has to be put to proof in practice.

Medicinal Treatment of Plague.

Outside serum-therapy very little can be done in the way of the treatment of the majority of cases. Where a bubo has formed, it is essential that the parts near it should be kept absolutely at rest, if at all possible, as there is then decidedly less chance of a general septicæmia following than if the bubo is constantly irritated by friction and the movement of the surrounding part. Constipation should be treated with calomel at the commencement; vomiting by small doses of morphia or bismuth and hydrocyanic acid and by counter-irritants; threatened heart failure by strychnine and large doses of alcohol in some form or other. Strychnine in small doses all through the disease has proved of the greatest benefit in many hands. Cerebral symptoms should be treated on ordinary lines. Sleeplessness may be met with moderate doses of morphia in the early stages of the disease, and smaller doses later on. Other hypnotics are practically useless, and from a very large experience now, I find that wherever it is desirable to give a hypnotic, morphia is the best. Corrosive sublimate solution has been given internally in doses which would ordinarily cause profuse salivation. A series of cases in Bombay gave apparently good results from this treatment, but I am somewhat sceptical concerning these results, as I cannot see any physiological or pharmacological reason why mercury should have any action on the plague bacillus and its products unless it were given in doses which would do more harm to the patient than to the disease. That any local application has any alleviating effect on the pain is also doubtful, but the moral effect of such treatment amongst Asiatics is considerable, and a judicious yielding to the suggestion that such treatment should be applied is often necessary. Carbolic acid and tincture of iodine have also been given, and a considerable amount of success has been claimed for such treatment, but it is probable the same cases would have recovered even more rapidly with stimulent treatment alone.

Instruction of the healthy Community.

It has often been my experience that the instruction of the healthy on plague matters has been of the greatest benefit in helping to get plague measures carried out with a minimum of opposition and disturbance. In India I was frequently informed that, on attempting to argue with the healthy members of an infected family, it was hopeless to get any other expression from them than "It is fate and therefore it cannot be helped." This is mainly true, but I found in many instances that preaching to the healthy on the dangers which they ran in not insisting on the removal of the sick was followed by less reluctance to move out on the part of the patient's relatives. My impression is that a popular pamphlet on plague should be written by some one well versed in Native literature and its methods; in this the dangers associated with the disease should be pointed out to the multitude, and such information concerning the disease as is not distasteful to the Natives placed before them. It is almost unnecessary to add that a judicious amount of imagination could be indulged in, to suit Native ideas and custom. Authorities on what should be and what should not be inserted in such a pamphlet might conveniently add to it all the sayings of priests, deities, and other influential people which might be construed as favourable to the carrying out of plague measures. This might even go so far as to point out all the actual commands which may be found to bear on the subject of cleanliness, general sanitation, and rules to be observed in epidemic times. Such a pamphlet, of course, might have to be modified to suit the convenience of different castes and races in India. That such a pamphlet would do a large amount of good I have no doubt, although some of those with whom I had conversations on this subject whilst in India seemed to be of the opinion that it would be waste of energy. I only give this as a suggestion, but in

the firm conviction that if acted on it would undoubtedly lead to good results.

Cleansing of Towns.—This no doubt, in a general way, is necessary, but the whitewashing of districts of a city or large town, where there is no plague, is waste of labour and money, and this may have to be done every month or two over a period of years. What should be done in this line, however, is to whitewash with chloride of lime the houses in close proximity to any centre or centres of infection, whilst at the same time the inhabitants should be provided with a supply of chloride of lime to be spread about the floors, so as to prevent as far as possible infection of and by rats. Any attempt to keep the interiors of houses perpetually clean with the present state of insanitation and the filthy habits of the people in India is almost hopeless. In cities and large towns the carrying out of the present municipal laws would result in improvement—but the municipalities seem to be unable to carry out the provisions for keeping their cities and towns clean, even with well drawn-up Acts and the fullest powers conferred on them by Government.

Venice Conference.—I only desire to mention the Venice Conference to point out that by far the most important point is still left unsettled. Its report is only the application of common sense to our knowledge of plague. This important question is, when is medical surveillance in one's own home to end and medical detention for observation to begin? I would point out that in India the former is never safe, whilst if the latter can be carried out with proper disinfection it will always be safe—if carried out with a strong hand from the beginning, it will save countless lives and large sums of money.

One weak point in the Venice Conference report is the matter of disinfection of dirty linen and other susceptible articles. Ships coming from an infected port should have all these disinfected *before leaving*, under competent supervision, more especially the kits of the crews, where the greatest danger of introduction of plague into Egypt and Europe lies. If this is done the present small danger will be reduced, as it will prevent the possibility of late infection occurring after embarkation, a possibility which some day may render the present "10 days' " clause liable to further extension, and which, as has been proved by the introduction of cases into England, still remains a risk to be guarded against. Had some of these cases escaped hospital treatment, no one knows what might have happened. Infection by other so-called susceptible material (except rags) on ships is as nearly chimerical as it can be.

Another clause might have been added with benefit. There is no doubt infection of plague *might* be carried by rats on board ship. I therefore think that ships should be moored out in the harbour or stream and not allowed alongside wharves in infected ports. This is very little hardship, and the fact of their lying out in the harbour might be inserted on their clearance papers for the information of foreign authorities.

Necessity of working with a trained staff.—It is hardly necessary to add that on an outbreak of plague in a new district it is advisable that work should be carried out by a trained staff; the importance of this cannot be over-estimated. It is not wise to allow the local authorities to work alone. A trained staff can commence good thorough work in 24 hours, where a locally procured staff seldom gets to the same state in a week. Even then it takes them some time longer to learn further details. The difficulties of procuring a local staff after panic has set in are great, and much time and money are lost in consequence. The expense of keeping up a trained staff will certainly be much less, as fewer trained men can do the work, whilst imported labour is usually cheaper; in addition to this, those imported who have had previous experience go about their duties with confidence, and not in the semi-frightened manner in which Natives and even Europeans who are making their first acquaintance with plague go. Until an unprejudiced person has seen or experienced the difference between trained and untrained workers it is hardly possible to conceive how much depends on the existence of a trained staff; in fact, when set to work in the early stages of an

outbreak, it makes the difference between an epidemic or not, as the question at issue is whether the disease is to be scotched during the period (a fortnight) that the new staff is being trained—the most important point in the whole of plague operations. This point of working with a trained staff is all the more to be insisted on in India, where so many of those trained must necessarily be Natives, and where consequently the gain or loss of time is very great indeed. It is, of course, sometimes difficult to persuade local authorities that their efforts are both insufficient and inefficient.

As time goes on it may be possible to replace some European by Native help, but it is imperative that, to begin with, Europeans should be employed; Natives cannot or will not do the work properly.

In July the staff for working plague seemed to be sufficient, but from the telegrams lately received one is led to the conclusion that the supply of female help is inadequate. When it is considered that, in addition to the women required for nursing there should be others for the inspection of female corpses, as well as searchers in considerably larger numbers, it is evident that the supply of nurses or lady doctors must at present be too small for carrying out successfully the work required. This is said on the assumption that the scarcity of female helpers who could be procured locally remains as it did six months ago. It is natural that there should be a disinclination to incur a large expenditure where there is some doubt as to how many would be necessary, but this is only one of the uncertainties which must be reckoned with in plague. All the duties that have to be carried out by women can be performed perfectly well by ordinary nurses, as a week's experience in a plague hospital is usually all the training that is necessary. These can be procured at from a third to a fifth of what lady diplomates would cost. Should it be resolved that a further increase of observation camps is necessary, as has been suggested, it is also necessary that an addition to the ranks of female helpers should be made. My experience is that such nurses are quite competent after a very short probation period to take charge of a hospital or the female side of an observation camp.

I have tried to show that by working on the lines described in this Report and by making a determined effort to carry out the details mentioned, *plague can be controlled*. The matter is in great measure one of system,—of men and money. The various and varying opinions of Indian officials as to the possibility of carrying out many of the details, and as to what can and what cannot be done without interfering with racial and caste prejudices, are so numerous and divergent that I prefer to go to my own experience for guidance on many or most of the disputed points. The different opinions no doubt are due to differences in the character and experience of the individuals holding them. It is well known that some men have great power and influence over natives and the native mind, whilst in other men this power seems to be entirely lacking. Some men appear to have no difficulty in getting subordinates to carry out the details of plague work; they know what should be done, when to insist, and when to give in. Such men at the head of a trained staff will succeed where others absolutely fail. These are the men to place at the head of a plague staff; they must be the generals in command of the forces that have to carry out the campaign. Such a campaign should first be an affair of cavalry scouts,—a beating up of the country to find out plague spots at the earliest possible moment; and in the next instance acting on the information so obtained, manœuvring to prevent the enemy from taking up a position favourable for a big attack. It is essential that the man in command should know every detail in connection with his enemy and his army—plague and plague workers; he should know everything from the price of, and where to obtain, a whitewash brush to the latest advance in the bacteriology of the disease. Thoroughness is absolutely indispensable. Half knowledge and half measures I regret to say are almost as useless as they are costly.

Plague can certainly be worked with a minimum of interference with caste. This should be carefully borne in mind. The opposition met with from the natives is in great measure due to their fear of interference with caste. This fear gives rise to great obstinacy on the part of the people, which usually, however, vanishes before decision and tact. The term "political difficulties"

always looms out in strong relief. There is no infallible method for overcoming caste prejudices and political difficulties; the overcoming of these greatly depends on the thoroughness, tact, and forbearance of the man on the spot. That they have been, or at least were, overcome in most of the Bombay Presidency, and that in many places these measures have been carried out thoroughly with the greatest success is certain—as for instance in Scinde and Poona. Although Poona has since been re-infected from Lanowli, for some considerable time it was completely free from plague, and had it been possible to isolate the city it would have remained free, as the disinfection there was of a thorough description. These measures too were carried out with very little interference with caste. Since the murder of Mr. Rand, many natives have come forward with assurances that the plague operations in Poona were carried on in a way with which little fault could be found, although at the time those who were engaged in them and were aware of the untruth of the allegations made against them, even by their own countrymen, had to stand by and bear gross abuse in silence.

It must always be remembered that the plague bacillus is not influenced by diplomacy. It waits for no man. Operations against it must be commenced with the greatest rapidity; there is no time for lengthy deliberation, therefore all local plans as regards hospital and similar arrangements should be cut and dried so that there may be no delay when the central organisation has to step in to assist the local authorities.

By working on the lines laid down, and by constant pushing to advance along them as far as possible, by being constantly on the watch for every fresh case, the mortality from plague from some thousands per week was reduced in the official week ending 9th July to 62.

The appendix here given consists of some short notes drawn up for the use of rural authorities at the commencement of this work in India, in which have been made a few slight alterations, found necessary during Indian experience.

In concluding this Report I should like to say that my remarks have been purposely confined to practical questions concerned in the suppression of plague in India. The more scientific aspects of the subject can be more appropriately treated in medical and scientific journals, whilst it scarcely comes within the province of the report to indicate the reasons, official and physical, that led to such a rapid extension of the disease in the Bombay Presidency. It will be recognised that from my position in India—going as I did with a somewhat ill-defined official status, with perhaps knowledge and experience of the subject as my only qualification—a certain amount of friction may have been engendered, especially in connection with the regular servants of the Indian Government. On several occasions I found my position a difficult one on this account. I trust however that any friction, which, after all, was usually merely temporary, was soon forgotten in view of the great interests which I conceived were committed to my charge. The necessity for promptness in action, the inadequate resources at disposal, especially as regards disinfecting material, the many difficulties which had to be unhesitatingly met and the responsibilities I many times had to assume, obliged me to ignore what under less urgent circumstances may be an appropriate official routine. My judgment may have been, and no doubt sometimes was, at fault, my methods may have been rough and manners brusque; my desire to do what I conceived to be my duty is now my only excuse.

I must take this, the only opportunity I shall have of acknowledging the courtesy and kindness of many of those with whom I was frequently brought in contact, often under trying conditions. I am deeply grateful for the great consideration which I received from His Excellency Lord Sandhurst, without whose energy and guidance any little good which I may have been able to do could not have been effected. I also desire to thank His Excellency for much personal hospitality and kindness.

I have the honour to be,
Sir,
Your most obedient Servant,
JAMES A. LOWSON.

APPENDIX.

Memorandum on Plague.

(1.) *Preventive Measures.*

These are mainly the ordinary dictates of sanitation.

1. Drains and sewers should be thoroughly flushed with a strong stream of water. Do not use disinfectants for this purpose; it is merely wasting them.

2. The death-rate should be closely watched. An increased death-rate must be looked upon with suspicion, unless there are local circumstances which can account for it. Surprise visits should be made to houses in which there are known cases of illness. An increased death-rate necessitates strict investigation.

3. In cases of death, where a suspicion exists that it may be due to plague, the body should be examined by a doctor or medical subordinate. In towns where there is an available medical staff, all bodies should be examined. This examination is most important as conveying the earliest information of the importation of the disease.

Notification of death should be made compulsory, and as far as possible the cause of death also.

All cases of sudden fever, swelling of glands in neck, armpits, or groins, cough with pain and oppression of chest, should be reported at once to the authorities. Notification should be made compulsory, and means taken to let the inhabitants know it is compulsory.

4. In towns and villages rats undoubtedly convey the disease from house to house and from district to district. Means should therefore be taken to destroy as many as possible; the danger arising from their presence should be pointed out to the inhabitants. All dead rats should be burned. When dead rats are found in an uninfected district, they should be examined by a medical man and preparations made for bacteriological diagnosis. Rats' spleens and lungs, if required to be sent to a central authority for diagnostic purposes, should be taken from as recently dead animals as possible. A small bottle of alcohol should have some cotton wool placed in it and the organs then dropped. If no alcohol is at hand, a 1 in 2,000 solution of corrosive sublimate should be used.

5. Burning of all excreta should be carried out when feasible; in any case they should be buried. Public latrines should be frequently whitewashed.

6. Overcrowded and insanitary houses should have immediate attention paid to them. In the case of the former, part of the inhabitants should be turned out and housed elsewhere, whilst insanitary houses should be closed until the defects have been remedied.

The free entrance of light and air is of the first importance, and obstructions to these should be freely removed.

7. The inhabitants should be informed of the efficacy of disinfectants in stopping the spread of the disease when they are thoroughly applied, and instructions for disinfection freely distributed. This refers to clothing and houses and their contents, especially to floors of houses.

After touching a patient, and especially clothing soiled by excretion, the hands should always be thoroughly washed in a disinfecting solution. Excretions of all kinds are an important source of infection.

8. The inhabitants of villages should be urged to prevent the entrance of all persons who they have reason to believe have come from infected areas.

The arrival of such persons should be immediately reported to the nearest Police authorities, who should take instant steps to disinfect the person's clothes and baggage, after which he should be isolated for ten days. Hand-bills should be distributed amongst the inhabitants of a district, pointing out the virulence of the disease and the rapidity with which it spreads, so that they should know the danger they will run should the disease be introduced.

The necessity for the segregation of people from infected areas that the customs of the country admit of, or a perfect system of daily observation, combined with personal cleanliness and municipal sanitation, should be impressed on all, as being important factors in preventing the entrance of the disease and its spread when once imported.

9. All stagnant pools of decomposing organic matter in the neighbourhood of habitations should be immediately filled up with fresh earth. All accumulations of filth and rubbish should be burnt or buried.

(2.) *Preparatory.*

1. Hospitals for the sick and segregation huts for the probably infected should be erected close together, so that the segregated may visit their sick relatives at intervals. The proximity of hospitals to the segregation camps is essential, as it will tend to diminish objections on the part of the people to these methods if all the family are housed in practically one camp.

2. In selecting a site, the following matters require attention:—

- (1.) Good water-supply.
- (2.) Site where wet weather will not flood the patients out, nor make matters too uncomfortable for attendants.
- (3.) There should be facilities for the removal of the large amount of water required for washing purposes, &c.
- (4.) Disposal of excreta.
- (5.) Easy access.
- (6.) Proximity to burying ground and burning ghât.
- (7.) Easy isolation.

3. Sheds should be erected for certain main groups of castes, with a partition between males and females. When hospitals and segregation huts are built by private members of the community, close supervision is necessary to see that their arrangements are of a sanitary description, which includes proper isolation.

4. Administration huts should provide accommodation for doctors, apothecaries, dispensary, female nurses (if any), ward attendants, dhobies, cooks, night-soil coolies, camp followers, kitchen and disinfecting room. Each hut should have a board hung up denoting for what purpose it is being used. An observation hospital hut is also necessary.

Segregation camps should have their huts small and numerous rather than large and few.

5. A stock of the following disinfectants should be laid in:—

- (1.) Carbolic acid.
- (2.) Corrosive sublimate.
- (3.) Quicklime.
- (4.) Chloride of Lime.

These disinfectants are the best for use in plague.

6. Large cauldrons should be procured for disinfecting clothes, &c., by boiling, as this is the best and cheapest method of disinfection for articles which are not seriously spoilt by the process.

Barrels cut in two form most effective wooden tubs in which corrosive sublimate disinfection can be carried out. Do not use metal buckets for corrosive sublimate solutions.

7. The hospitals should be only partially equipped if stores exist whence the remainder of the equipment can be procured rapidly.

8. A suitable burying ground should be selected; a separate one for plague burials alone is recommended.

9. Arrangements for the organization of parties for—

- (1) house to house visitation,
- (2) removal of sick and probably infected,
- (3) removal of dead (sometimes necessary), and
- (4) corpse inspection (if not already done),

should be made. The sanitary staff may require strengthening for white-washing and disinfecting processes if plague breaks out. Suitable ambulances will have to be procured for the sick.

The principal difficulties are—

- (1.) Procuring native medical assistance.
- (2.) Irregularity of houses preventing successful searching.
- (3.) Procuring female assistance, hospital accommodation, &c., for purdah women.
- (4.) In addition to usual native obstruction, the prevention of free handling of dead bodies.
- (5.) Labour. If an epidemic has commenced and labour is scarce it has been proved to be sound policy to utilise it all at once on building accommodation in preference to going on with town work.

Prior to plague breaking out, it is advisable that a proclamation should be issued to the inhabitants that certain measures will be adopted in the way of isolation and segregation, but that every precaution will be taken to preserve caste distinctions. Each community should be invited to erect their own hospitals and segregation huts, but at the same time they should be clearly given to understand that these institutions will be under official supervision. The necessity of removing their sick at once to hospital should also be impressed on them, both on account of the better chance of recovery and the less chance of compulsory measures being carried out which might interfere with their caste system.

It cannot be too strongly impressed on all, that provided the above measures are carried out, the first cases of sickness isolated at once, the people immediately in contact with them segregated and the house thoroughly disinfected, the probability of the disease assuming epidemic dimensions will be greatly lessened, and this will be proportional to the thoroughness with which the work is done.

Roughly speaking, the main links of the chain by which the disease is spread are—

- (1) human beings,
- (2) infected houses and contents,
- (3) rats,
- (4) clothing of infected,

always remembering that man is the great factor in spreading it over a distance.

To non-professional plague authorities the general signs and symptoms of plague may be summarised thus:—To commence with there is usually high fever with considerable headache, which may be either throbbing or boring in character. There is frequently a feeling of chilliness which may amount to a severe shiver, with severe pain in back and limbs occasionally. The pulse generally rises to over 100 per minute, full and easily felt in the early stages, but weak, more rapid and difficult to feel in the later stages of the disease. Respirations are also increased in number, rising from a normal of 15 to 18 up to 20—30 or more per minute. In adults the glands of the groin, armpit, or neck are usually enlarged and tender; in children the neck or armpit glands are more frequently affected than those of the groin. In the early stages there may be a dry hacking cough without any sputum; in later stages the sputum may be copious, thick or thin, and sometimes blood-stained. A feeling of intense oppression or weight about the heart and stomach is frequently complained of. Delirium comes on early in the disease, and may be of a quiet and stupid or very violent type. It is shown by incoherence of speech, inability to protrude the tongue properly, and tardiness

and tremor in doing so, as also inability to concentrate attention on what one says to the patient—being unable to fix the eyes straight on the questioner's face. The eyes are generally somewhat inflamed (suffused) and occasionally jaundiced. A tottering gait is usually well marked early in the disease, walking along a straight line usually being an impossibility. Inability to retain excreta must be viewed with suspicion, as this frequently occurs in plague. These are the main symptoms. Carbuncles, boils, hæmorrhagic spots, &c., are so seldom met with that little attention should be paid to them outside hospitals.

(3.) *When Plague has broken out.*

1. All sick should be at once taken to hospital, and relatives and friends occupying the same room, or who have been exposed to the infection, should also be isolated.

2. At the beginning and the end of an epidemic comparatively large numbers of people should be segregated, as these are the times for its greatest necessity, not to mention the fact that accommodation will not be strained then.

3. Thorough disinfection of the house from which a case has been removed should be carried out, and the house closed until the inhabitants have completed their segregation period of ten days. The contents of the house must also be disinfected. Nothing should be allowed to be removed until disinfection has taken place—particular attention must be paid to this.

4. Where dirty, the inside of all houses in the infected district should be limewashed as a sanitary measure. In this case good chloride of lime is preferable to quicklime.

Good chloride of lime spread freely on floors will undoubtedly lessen the chance of infection of a house, especially by rats; and even after a case has occurred in a human being in that house, it will lessen the chance of infection of the healthy. In an infected district this should be carried out in all houses.

5. After the observation period has ended, the people may resume occupation of the house, presuming that the disinfection has been carried out properly, and that it has not been found necessary to evacuate the district in which it is situated.

In an epidemic all cases of fever should be treated as suspicious and removed for observation; they usually turn out to be plague. The patient has a better chance of recovery by this procedure, and the chance of surrounding friends becoming infected is very greatly lessened.

(4.) *Disinfection.*

Infected rooms in houses.—In all of these there should be a preliminary disinfection by chlorine before an attempt is made or allowed to remove anything in the house. This is done by first spraying the walls, floors, and contents of the house with water. Then add one pint of water to one-third of a pint of sulphuric acid and pour this on to a pound and a half of chloride of lime in an earthenware vessel. All windows and doors should be shut and holes closed by paper before the materials are mixed. The above amount suffices for one thousand cubic feet—say, a room eight feet high and twelve feet by ten. If the house be of the better class, only the room which is infected should be treated thus; if a bad house, all the rooms should be treated and the house shut up on the certificate of a medical practitioner.

Another method of chlorine disinfection may be used, but this requires more laborious preparation. Take eight ounces of common salt and two ounces of dioxide of manganese and add them to a mixture of two ounces of strong sulphuric acid and two ounces of water. This suffices for a room of the size mentioned above. In this case also the house and its contents should previously be rendered moist.

Where this preliminary gaseous disinfection is carried out the chances of workers being infected is reduced to a minimum. Many native houses, however, cannot be treated thus.

Instead of this chlorine disinfection, if hand-pumps and corrosive sublimate or carbolic solution be at hand, disinfection can be carried out by these agents. Good mops may be used almost as effectually as hand-pumps, but the work will proceed more slowly. The lower two feet of the walls of the room must be washed down by hand-pump with a solution of corrosive sublimate (4 oz. of corrosive sublimate and $\frac{1}{2}$ lb. of common salt to 30 gallons of water) or carbolic acid solution (one quart to 25 gallons of water with a small handful of soft soap added to enable it to be mixed properly); all old clothing, bedding, and general rubbish should be taken out and burnt; all good clothing should be dipped in one of the disinfecting solutions for half an hour or into boiling water and thoroughly boiled for at least 30 minutes. Any partitions, shutters, &c., ordered to be removed by a medical officer should be burnt in the street; all crevices, angles of walls, junction of floor with wall, should be thoroughly mopped with a disinfectant solution. If the floor is composed of earth, it should be treated with a disinfectant solution and then removed to a depth of two inches. After this has been done the walls and roof (where necessary) should be properly whitewashed.

Feeding and drinking utensils and other house gear lying on floors should be rinsed in carbolic lotion and put out in the sun whilst the house disinfection goes on.

The officer in charge of party should order part of the roof to be removed if he considers it necessary for admission of light and air. The outside of the house does not require limewashing.

In non-infected rooms of infected houses the chlorine or first fluid disinfection need not take place, but, after whitewashing, the floor should be thoroughly swabbed out with some of the disinfectant solutions. The earthen floors in non-infected rooms need not be removed.

In infected houses where grain is stored the chlorine disinfection should always be attempted, and with a double strength of chlorine—grain bags should be lightly sprayed with water beforehand. After opening the house the grain bags should be removed and exposed to the sun for two days, whilst loose grain is simply spread out on boards or slabs of stone in the sun for the same time.

All the lower class inhabitants in the immediate vicinity of an infected house should be enjoined to take all their clothes to be disinfected either in one of the solutions or in the boiling water.

All stagnant filthy pools should be filled up with earth. If they are evidently badly polluted they should be treated with some of the disinfectants on the spot and then filled up. A careful search should be made for all filth, and when discovered it should be treated with quicklime and buried by the scavengers or removed to the night-soil depôt. If any fires are close by, the safest and best method is to take all such filth and burn it along with other rubbish.

The necessity for thorough and systematic disinfection should be impressed on all subordinate officers.

Partly pukka huts—*i.e.*, stone or mortar walls with cocoanut-leaf or other temporary roof—should be disinfected as follows:—

The roofs should first be removed and the leaves exposed to the sun—being occasionally turned during the time taken for disinfecting, &c.

The floor should be mopped with corrosive sublimate solution and also the lower foot of the walls—particular attention being paid to the crevices and the junction of the walls to the floors. Any partitions should be removed and either burnt or whitewashed. The walls should then be whitewashed. The roof should be replaced about the fifth day afterwards, and the hut may then be re-occupied.

Good quicklime only should be used.

Where corrosive sublimate or carbolic acid is not available in sufficient quantity, limewashing the floor is the best alternative.

To all corrosive sublimate solutions some aniline blue should be added to colour it; this will assist to prevent the solution being used for potable purposes.

Where dead rats are found in an infected house or neighbourhood they should be burnt and a careful search made for rat-holes. If any are found free application of disinfecting solution is necessary. In houses with wooden floors and wainscoting these should be torn up to disinfect the rat "runs."

When dead rats are found in any house it should be disinfected; here good chloride of lime spread on the floors is of great service (*see above*). Where practicable the house should be evacuated for a time.

[*N.B.*—Compensation should be paid early, and before destroying anything let the people know compensation will be paid where necessary.]

(5.) *Hospital.*

The hospital should be built on open ground, freely exposed to the sun and air. Isolation, so far as human intercourse is concerned, should be as strict as possible. The floor, if possible, should be made of some non-absorbent material that can be flushed with water; if of earth, chloride of lime should be freely sprinkled over it daily.

Ventilation should be carefully attended to by leaving open spaces between the walls and the roof. The huts should face the prevailing wind and should be erected in echelon.

On admission, the clothes of the patient should be boiled in water for at least half an hour and then hung up in the sun to dry. Any spare clothes and bundles which are brought with him should be similarly treated. The patient should have a bath or be washed down if his condition will permit of it. The clothes of any relative or friend who is permitted to remain with the patient should also be disinfected in a similar manner. As a rule only one friend should be allowed to act as attendant on a sick person. Non-attention to cleanliness of patients' clothing is one of the causes of infection in hospital.

Disinfectants *must* be freely used in the hospital, all ward utensils being frequently treated, as also all bedding. Cotton wool should be used for wiping up all discharges, and then burnt. Urine and fæces should be mixed with liquid disinfectant and afterwards burnt. Sputum cups should be provided in all cases, some carbolic acid lotion being poured into each, as the sputum is a known vehicle of infection.

Tumblers, feeding cups, &c., should be frequently dipped in disinfecting solution, or even allowed to remain in it when not in use, especially where friends do the nursing.

Any friend nursing a patient should be treated as a hospital attendant, and not allowed to communicate with the segregation hut. Segregation camp sweepers and attendants should be kept separate from hospital attendants.

The inside walls of huts should be frequently whitewashed.

All bed linen should be disinfected before being washed, mattresses destroyed if much soiled; if not, laid out in sun for a day or two before being again used.

A sheet or towel soaked in carbolic or corrosive sublimate solution should be always hanging up in a convenient part of the room for attendants to wipe their hands with. All wounds of the hand should be carefully treated.

If hospital fittings are not of a substantial character with polished surfaces, they should be frequently whitewashed, *e.g.*, beds, tables, commodes, &c.

(6.) *Segregation Camps.*

These camps should be formed to house suspected infected persons. These must be kept segregated for ten days, but the period may have to be shortened according to the size of the camp and the numbers to be segregated. Five days at least should be insisted on, as in those already infected the disease will probably show itself early.

Arrangements will have to be made for the proper hutting, feeding and conservancy of these people. The following rules for segregation camps are generally applicable:—

- (1.) A segregation camp should be divided into sections for each day's arrivals, according to the number of days it has been decided to enforce segregation.

No intercourse between the different sections should be allowed.

